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Construction Methods

Graw-Hill Publishing Company

January, 1935

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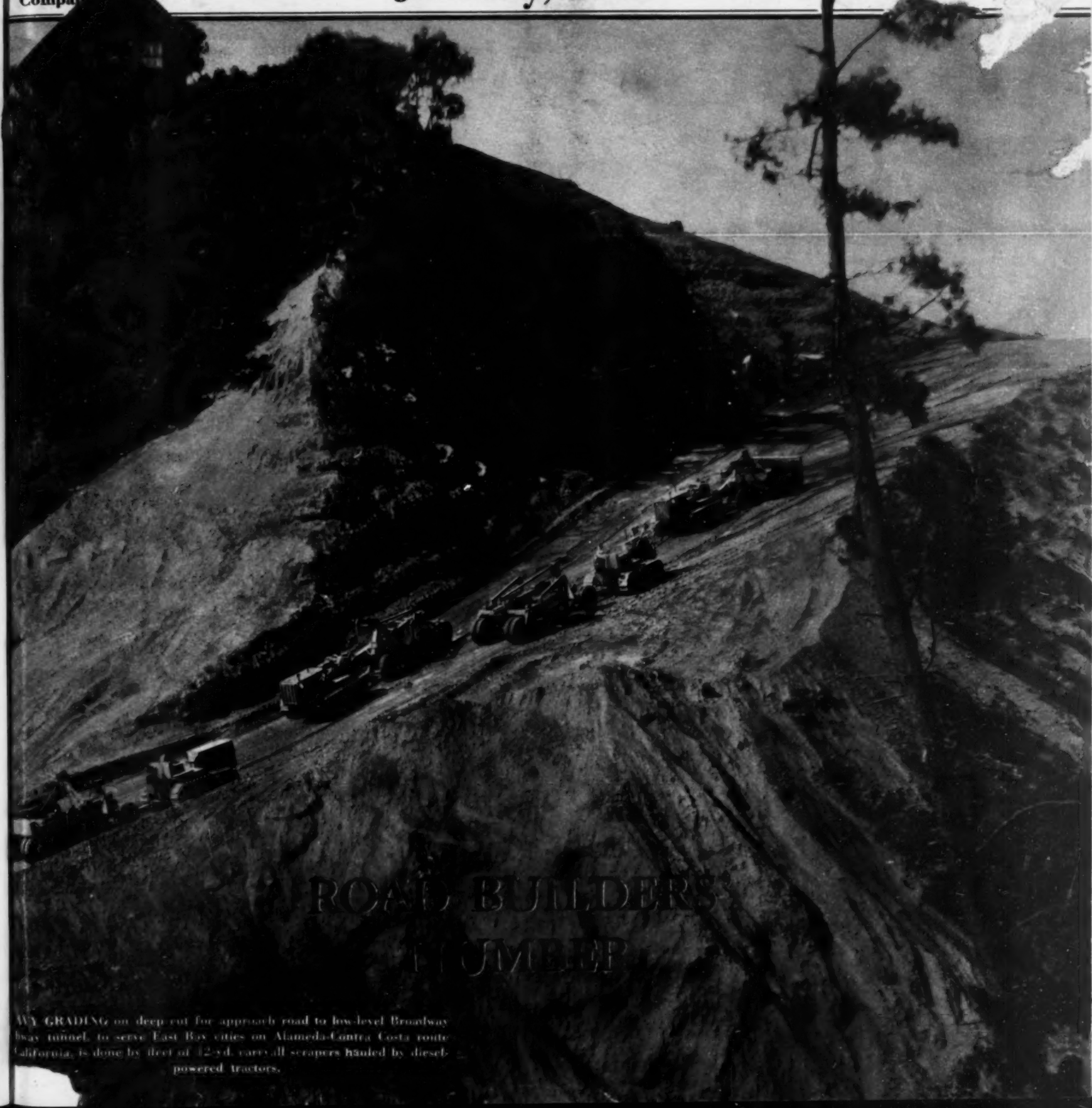

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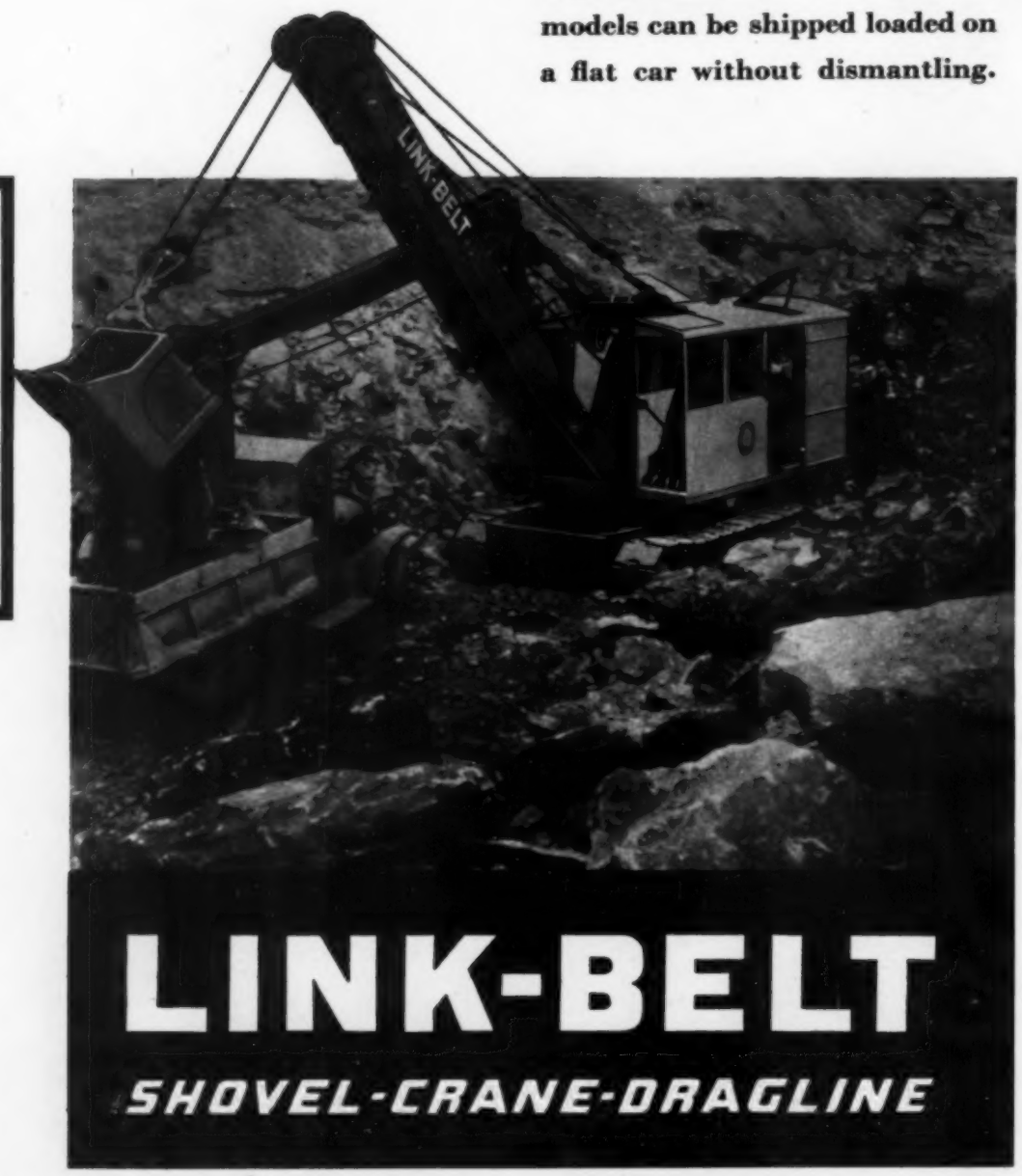

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TECHNOLOGY DEPT.

Construction Methods

McGraw-Hill Publishing Company, Inc.,
330 West 42nd St., New York

ROBERT K. TOMLIN, Editor

JANUARY, 1935

WILLARD CHEVALIER, Vice-President

Editorial Staff: Vincent B. Smith, N. A. Bowers (San Francisco)
Leonard H. Church (Cleveland), Nelle Fitzgerald

Annual Road Builders' Number

● *Construction Methods* presents herewith its Annual Road Builders' Number, appearing on the eve of the annual convention at Washington, D. C., Jan. 22-25, of the American Road Builders' Association. During the year just passed highway work, thanks to the stimulus of federal appropriations, has been fairly active, forming one of the comparatively few bright spots in an otherwise somber construction picture. In general, the principles of construction for the usual types of bituminous or cement concrete pavement have been pretty well standardized by now, but each year sees some improvements or refinements in field technique and in the equipment adapted to road-building purposes. In this issue will be found representative examples of such construction detail.

Last year a large amount of bituminous construction was undertaken and in the pages that follow this activity is reflected by a group of articles covering bituminous macadam, sheet asphalt, continuous road mix, plant mix and tar penetration. More accurate control of bituminous mixes and greater care in their application are characteristics of modern practice in this type of construction.

During the year highway engineers in many states undertook extensive relocations of existing routes to improve service to traffic by better alignment and grade and, of particular significance, by diverting through traffic around heavily congested metropolitan areas. Two notable examples of projects of this type are the relocated Cambridge-Concord Highway in Massachusetts and the new parallel bypass through the northerly suburbs of Philadelphia, both involving heavy grading and multiple-lane concrete paving.

In city paving, one of the notable developments of the year was the large-scale application of the new de-aired brick, a product denser, stronger, less absorbent and more near-resistant than the ordinary block. For the paved surface greater uniformity and stability are assured by the use of a tar mastic, instead of a dry sand, bedding course, while the removal of the objectionable excess joint filler from the completed surface is now made easy by the application of a spray coat of calcium chloride to break the bond between the brick and the hot asphalt, allowing the latter to be peeled off and re-used.

While engineers and contractors until recently have been devoting most of their attention to the actual road surface an important accessory development has occurred in attempts to improve the appearance of the sides of the road. This type of work, exemplified by a project in Minnesota, involves special grading and sloping, landscaping, planting of trees and shrubbery, removing eyesore structures and clearing to open up attractive vistas for the passing motorist. All signs point to the fact that in the years to come highway engineers will attach much more importance to this subject of roadside development than they have in the past.

Carlisle, New York Herald-Tribune Syndicate

Action Needed on the Pump Handle

Gasoline Tax Diversion

● Last year almost $200,000,000 was diverted in various states from the motor-vehicle and gasoline-tax funds. Much of the diversion was accomplished by legislative enactment, but more often the financial transfers were made by orders of the governors. Protests by interested bodies, such as associations of motorists, manufacturers and road-builders, were generally ineffective in preventing diversions in the states, but public sentiment was a factor in encouraging Congress to include a penalty clause in the Hayden-Cartwright bill restoring federal aid on a 50-50 basis to the states. By this act, any state using motor-vehicle and gasoline-tax funds in any way not provided by law at the time the bill was passed will be deprived of one-third of its federal allotment.

This penalty will serve as a preventive in states of small population, such as New Mexico, which will not wish to lose one-third of its share of nearly $3,000,000; but it can be only a slight deterrent to a state like New York, which may be willing to sacrifice one-third of its $11,300,000 allotment in order to divert $60,000,000, or more, from the highway fund to unemployment relief. Continued public resistance to diversion must be given expression at current legislative and congressional sessions to hearten the lawmakers in their effort to eliminate the practice. The governors also must be made conscious of the sentiments of those who pay the gasoline, vehicle and operators' taxes. Road-builders can do a service both for themselves and the state highway departments by presenting the case to the great body of taxpayers and carrying the verdict into the state capitols.

Wanted: A Tough Joint

● Subject to widespread discussion, experiment and invention, the search for a satisfactory transverse joint in concrete slab pavement continues on an extensive front, with the U. S. Bureau of Public Roads and state highway departments contributing their experience to the progressive evolution of improved designs. Contraction joints in themselves present a problem, but the major difficulties are centered in the expansion joint, which is now receiving most attention. Present efforts are directed to making the expansion joint stable, waterproof, non-extruding and capable of transferring loads between slab ends.

To prevent settlement and resultant slab fracture, designers have produced joints with various means of transferring loads across the opening. These methods of load transfer include round dowels, channel dowels, ledge joints, and several angle-dowel devices of peculiar shape. An underlying supporting slab is another method of preventing settlement at present undergoing test. Watertightness is obtained by using an elastic filler which adheres to the two slabs or by installing a hinged copper seal anchored in the two slabs. To avoid extrusion in warm weather, highway departments are testing cork, rubber and other compressible materials, as well as the so-called air-cushion joint.

Unsatisfactory service of older joints under the impact of heavy traffic and resultant high maintenance costs have inspired the present eager search for a permanent, durable joint. Some of the current designs appear extremely elaborate and high in cost. If they eliminate joint troubles, the cost cannot be considered excessive. The field is open for the development of further improved designs. Builders of concrete roads are ready to cooperate in a practical test of every promising new design.

CONSTRUCTION METHODS was founded in 1919, under the name of *Successful Methods*, by the Manufacturers Publicity Bureau, Inc., of Chicago, representing a group of non-competing manufacturers of construction equipment. Charles B. Thomas, editor of the first few issues, was succeeded by William Jahne.

In 1926 the McGraw-Hill Publishing Company, Inc., of New York, purchased the publication, changing its name to *Successful Construction Methods* in November of that year and to *Construction Methods* in May, 1927, in order more accurately to define its field and purpose.

Robert K. Tomlin was appointed editor of *Construction Methods* in January, 1928. Vincent B. Smith is associate editor, N. A. Bowers (San Francisco) Pacific Coast editor, Leonard H. Church (Cleveland) assistant editor and Nelle Fitzgerald, editorial assistant.

The President's New Program

AS THIS is written the President has just presented his message to Congress. In it he sketches the outlines of a revised public works program and although he leaves for later formulation the details of agencies and procedure, it may be appropriate to consider here certain aspects of the plan on the basis of his message.

In general the new program swings toward sounder policies than have prevailed hitherto. The President now stands squarely on the principle that federal relief must give way to employment. He insists that it is within the duty and the capacity of the federal government to find employment for the 3,500,000 employables now on relief, pending their absorption into private employment.

He would consolidate all emergency public works into a new plan but he explicitly excepts *certain normal public building operations of the government.* The italics are by this writer. The principles laid down to govern such emergency employment are, in the main, sound and practical. All work must be of long term value; compensation should be higher than a subsistence dole yet sufficiently below prevailing wages as to avoid making emergency employment more desirable than private employment. He specifies that projects shall compete as little as possible with private enterprise and that they be tapered off as private employment becomes increasingly available. Other provisions are of like rational tenor.

But this preliminary sketch leaves certain areas somewhat obscure; these must be clarified before the enabling laws can be enacted.

For example, he suggests that if it were not for the need of creating employment most of the emergency projects would not be undertaken. In itself that is reasonable. But in his list of contemplated work he includes the improvement of "existing road systems, construction of national highways designed to handle modern traffic" and "non-federal work, mostly self-liquidating and highly useful to local divisions of government."

On no account should these ambiguities be interpreted to justify a discontinuance of the present program of loans and grants for non-federal public works. Neither can they mean that the state and federal-aid highway programs now carried on by normal methods should be thrown into the emergency class. Such procedure would negative the President's avowed aim to foster the revival of private industry. Those projects form a substantial share of the business now available to the organized construction industry; as such they are contributing mightily to normal employment in many quarters.

Indeed, it would be more helpful to strike off the shackles now fastened on them by certain relief restrictions and requirements. If the President would achieve his ultimate purpose, he should exempt from his emergency program, along with *"certain of the normal building operations of the government,"* all normal public construction, non-federal as well as federal, and continue, through federal credits and grants to stimulate its volume on a normal basis.

One other phrase deserves consideration. "Projects should be undertaken," says the President, "on which a large percentage of direct labor can be used." The effect of this will depend on how it may be translated into law. If it be interpreted to justify an abnormal use of handlabor or a strained abstinence from the use of materials, it will be but a survival of the strange fallacy that already has bedeviled much of the public works effort.

It should be understood that those who find employment in the production, sale and transportation of materials and machinery are just as much human beings as those who are put to work on the job, that their employers are part of that "private industry" on which the President counts to take up the recovery burden and that the plants in which they are employed represent that "private capital" which must be put back to work if we are to return to normal.

The President himself surely is mindful of all this and no one else should stretch his phrase to mean more than it says, i.e., a "large percentage" of direct labor should be employed.

All in all this program is a long step forward. Wisely translated into law, it should help to put the public works effort on a sounder basis. But a sharp distinction must be maintained between normal public construction, prosecuted by normal methods, and those other projects, undertaken as the President points out, primarily for emergency employment. It would be a grave blunder to curtail the former in order to swell the latter.

Willard Chevalier

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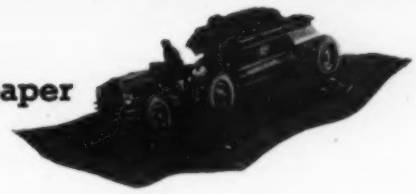
MOVING millions of yards faster and cheaper



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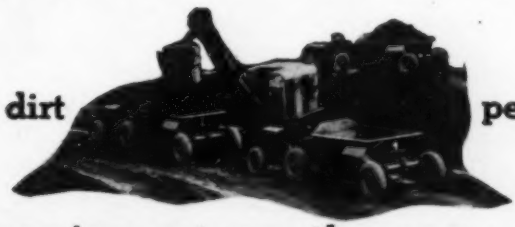
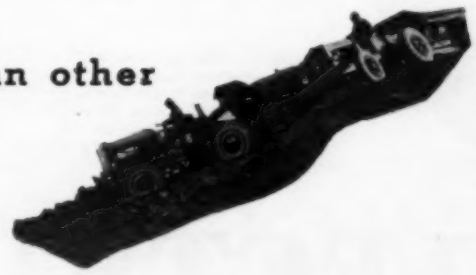


per hour than other



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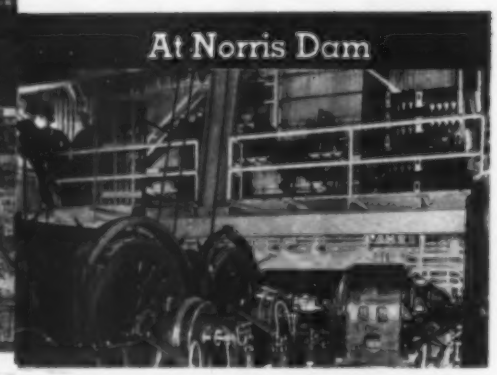
On the Front Line of the Nation's Construction

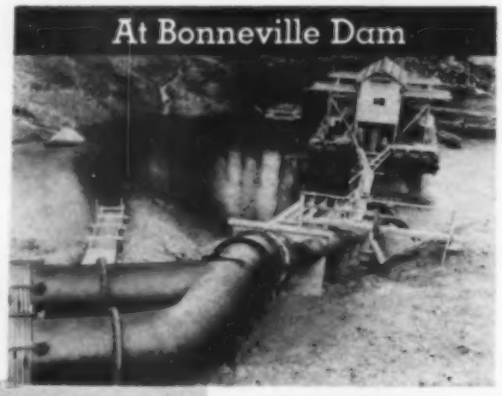
G-E EQUIPMENT

Gives Dependable, Economical Service

East bank of Norris Dam, showing tail towers of the two Lidgerwood cableways from which concrete is being placed. Cableways are completely equipped with G-E motors and control, including 75-hp. tower-shifting motors



Interior of cableway head tower at Norris Dam, showing G-E 400-hp. motor, and control panel, for bucket operation



G-E motors and control, direct-connected to four Bingham Pump Company centrifugal pumps on this barge, dewater the space in which the powerhouse is being built at the Bonneville Dam site. Capacity of pumping units, 60,000 gallons per minute against a maximum head of 90 feet

AGAIN AND AGAIN, for the important construction jobs in connection with the giant Federal projects, General Electric equipment is the choice of engineers and contractors.

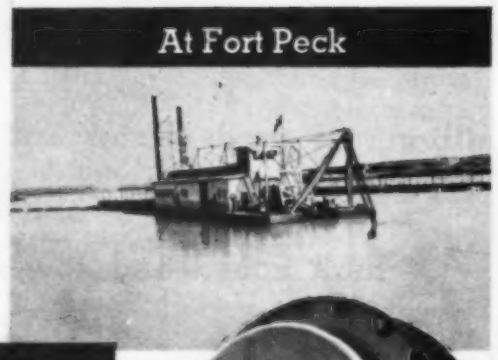
Illustrated on this page are a few of the many installations of equipment such as motors and control, transformers, and cable, which General Electric makes for construction work.

Motors and control—and all other electric equipment—on jobs like these must deliver efficient service under the strain of day-and-night operation. General Electric equipment, built to the highest standards of materials and workmanship, can be counted on to give dependable service under the most exacting conditions.

Economy is also of prime importance to the contractor. Because G-E equipment is carefully selected to meet the requirements of each specific job, its operating costs are low. Furthermore, its high quality assures long life and low maintenance.

Depend on the electrical equipment that others have found dependable. Specify G-E equipment for your construction jobs. General Electric Company, Schenectady, N. Y.

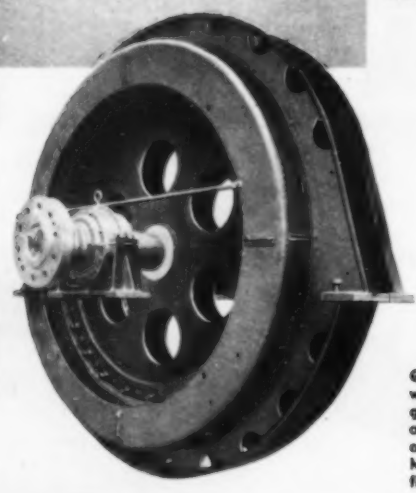
Ballasting track for head-tower operation at Bonneville Dam site. On this project two head towers, completely G-E equipped, will operate on a curved track, with one tail tower serving as an anchor. Span of main standing cable, approximately 1200 feet



Dredge "A" in operation at Fort Peck. Special G-E 700-hp. cutter-head motors are part of the dredge equipment

This G-E oil-immersed, 3-phase power transformer, for use at Grand Coulee Dam, is only one of many types of efficient, dependable equipment furnished by General Electric for construction projects

Two of four American Revolvers, built by American Hoist and Derrick Company, St. Paul, Minn., for handling all cement and aggregates used in making the concrete at the General Joe Wheeler Dam. These Revolvers are equipped with G-E 150-hp. hoist motors and control



G-E 2500-hp., 257-rpm., roller-bearing, wound-rotor motor. Twenty-one of these giant motors, with control equipment and auxiliary motors, drive the pumps on dredges and boosters at Fort Peck, Mont., where the world's largest earth-filled dam is under construction

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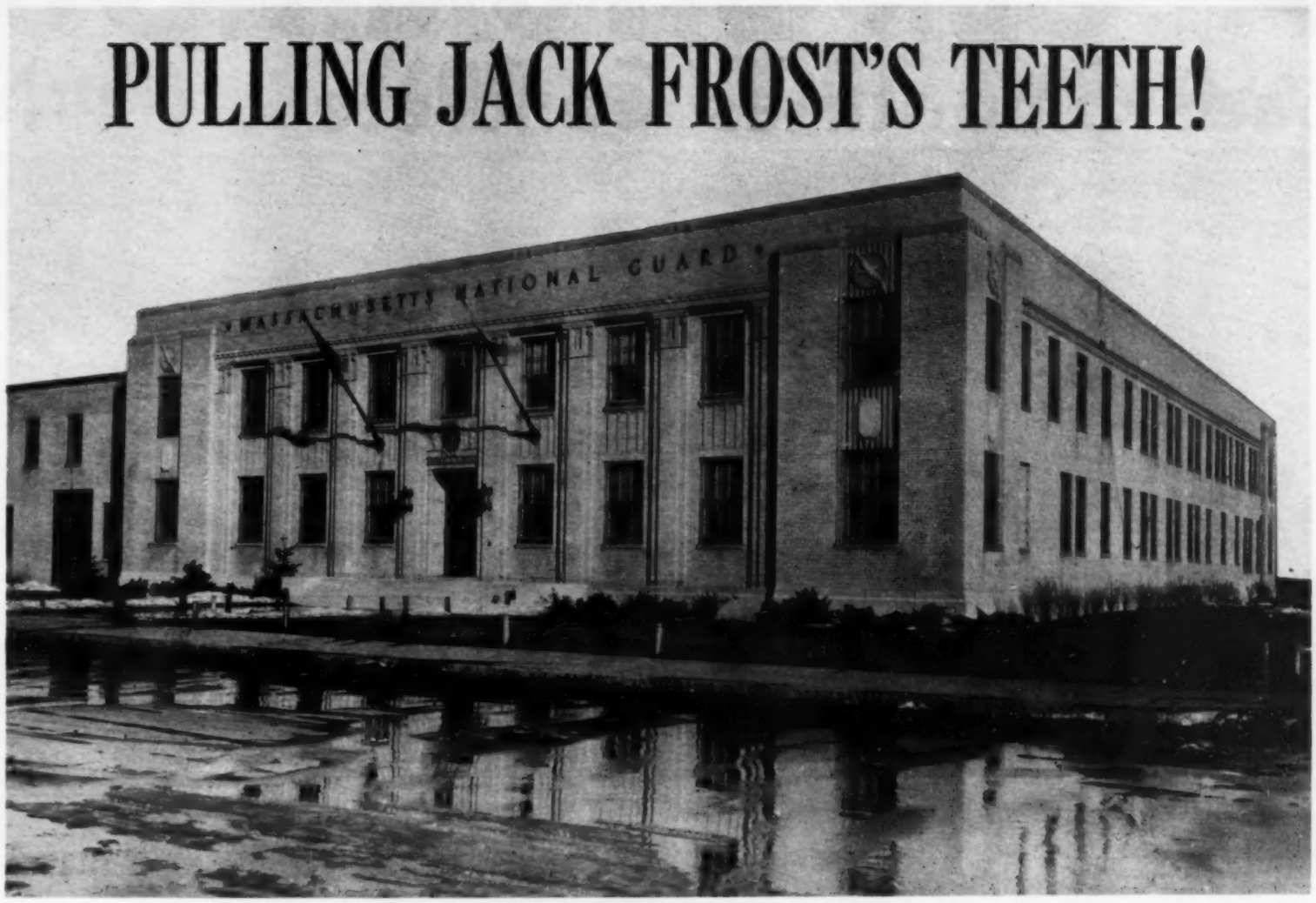
GENERAL ELECTRIC

PULLING JACK FROST'S TEETH!



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The quicker concrete hardens the sooner it is past the danger of freezing and the lower the cost of maintaining heat-protection. Because 'Incor' is a better, more thoroughly processed cement, it cures or hardens 5 times as fast as ordinary Portland cement. That is why 'Incor' concrete is safe from freezing 2 to 5 days sooner. Heat-protection costs are 60 to 70 per cent lower. Other savings include earlier form re-use—one form set does the work of several.

It pays to Switch to 'Incor'

Why not figure these savings. It has paid many contractors to switch to 'Incor' with the coming of Winter. Example: In constructing the Administration Building and Hangar for the 26th Div. Massachusetts National Guard, shown above, the engineer says:

"January temperatures were below freezing and building site very much exposed. To reduce danger of freezing, I recommended that the contractor use 'Incor' Cement. Materials were heated and salamanders used after concrete was poured. 72 hours' protection requirement was reduced to 36 hours. Earlier removal of forms saved much lumber; but the real reason for using 'Incor' was to reduce freezing hazards."

Write for New "Winter" Book

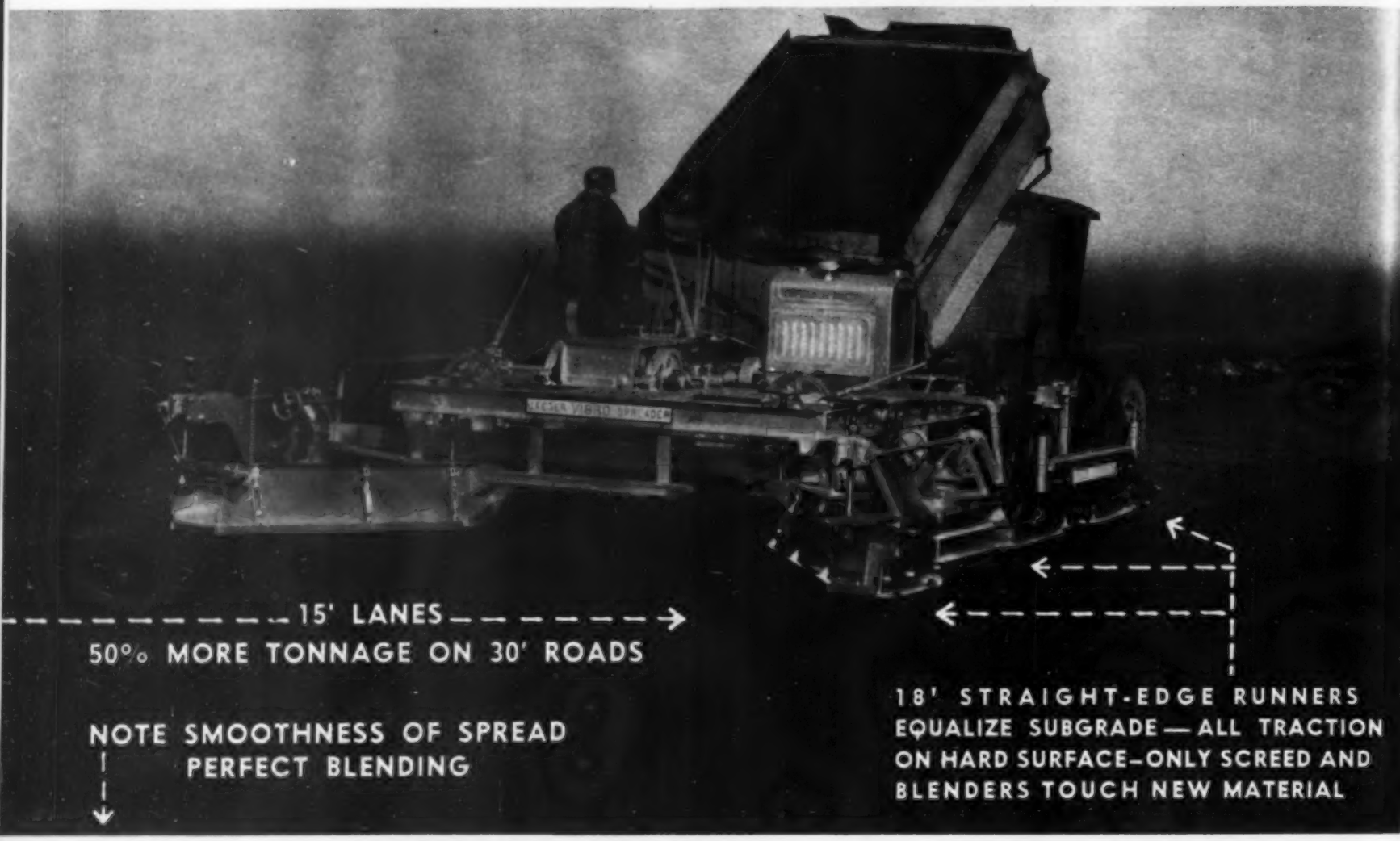
Write for free copy of new illustrated booklet, "Winter Construction." It is full of helpful and timely information. Address 'Incor' 24-Hour Cement, Room 2200, 342 Madison Avenue, New York. 'Incor'* is made and sold by producers of Lone Star Cement, subsidiaries of International Cement Corporation, New York; also sold by other leading cement manufacturers.

* Reg. U. S. Pat. Off.

'INCOR' 24-Hour Cement

JAEGER BITUMINOUS P

Roads Smooth as Concrete . . . No F



THE Jaeger Bituminous Paver combines the ability to lay smoother riding roads to the new high standards of highway engineers with operating features available in no other machine: —9' to 15' adjustability in width, traction on hard surface only, up to 50 per cent more tonnage capacity, adjustable blending screeds, differential steering and a big saving in hand work on the job. Powerful "re"-mixing screws spread material laterally.

Frame is telescopic for easy width changes. The full floating, 18-ft. long straight-edge runners are "movable forms" that equalize the road surface, give smoothness equal to form jobs on any

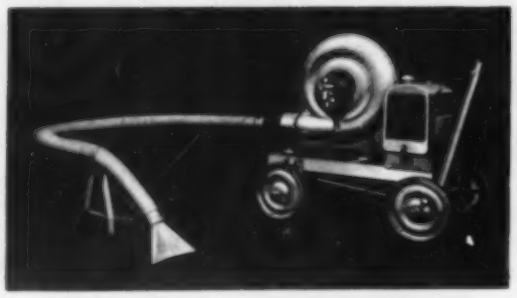
PAVING U. S. 1

Harry T. Campbell & Son, Towson, Md., laying middle strip of 28-ft. pavement on U. S. Highway No. 1 between Philadelphia and Baltimore. Jaeger Adjustable Bituminous Paver can lay jobs like this in 2 strips—50 per cent more tonnage, only 1 joint to finish.

Material used on this job is Maryland Standard Amiesite Mix 1½" base, ½" top. Machine easily laid better than 1 ton per minute of 1½" base, 9½' wide—produced unusually smooth surface in spite of curves and super-elevations with grades of 4 per cent and temperatures around 40 degrees.

1935 JAEGER-LAKEWOOD MACHINES

Dust Blowers



Life of a black top road is no better than its bond to road bed or between top and base. Sweeping merely fills holes with loose dirt—Jaeger-Lakewood Dust Blowers CLEAN THEM OUT—deliver up to 5800 cu. ft. of air per minute over 6-ft. path.

Powerful Blower driven by 4 cyl. engine, on trailer or 4-wheel roller bearing truck with automotive steering axle. Sizes to meet conditions—a paying investment whether specified or not.

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Adjustable Asphalt Forms

Cut your form costs by buying standard 8" flanged base and such inexpensive top rail as each job requires instead of complete new size form for every job. Simple lock makes change-over easy.

Jaeger-Lakewood Forms are nearest in alignment and rigidity to a continuous rail. Insure you against loss of material from "bowing," reduce chance of "high spots." Telescopic or male and female wedge joints. Heights to 5½".

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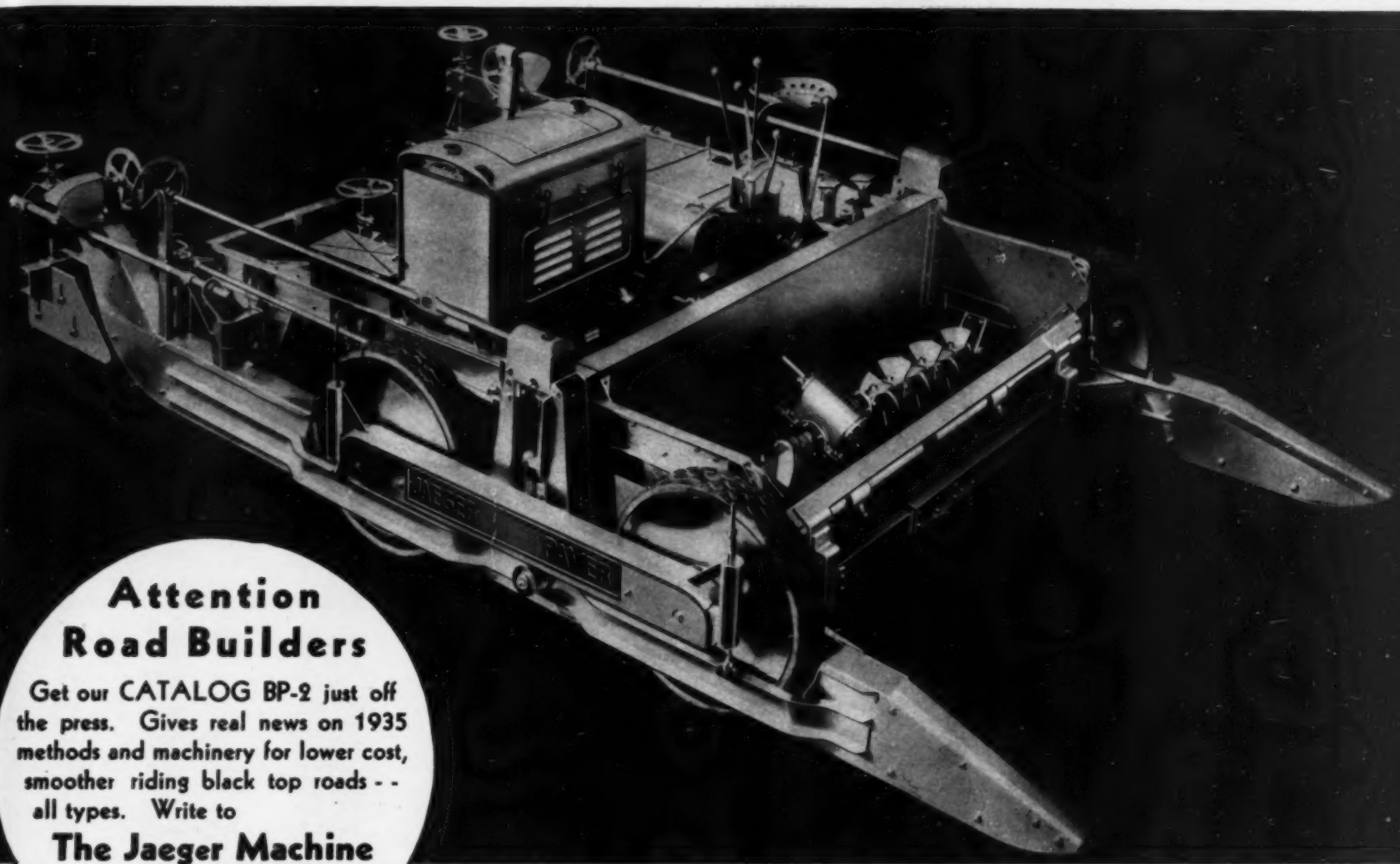

Attention Road Builders

Get our CATALOG BP-2 just off the press. Gives real news on 1935 methods and machinery for lower cost, smoother riding black top roads - - all types. Write to

The Jaeger Machine Co. (Lakewood Engineering Co. a Subsidiary)
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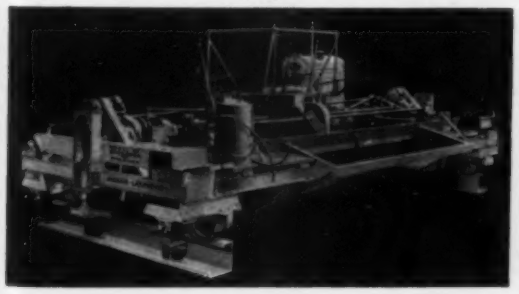
well prepared subgrade. There is no weight or traction on the newly laid material.

These are just a few high spots of this machine which is backed by 3 years of actual field tests and the longest experience in spreading and finishing equipment of any company in America. Send for new CATALOG BP-2 giving complete data on Jaeger-Lakewood 1935 equipment for all types of black top roads.

FOR ALL TYPE OF BITUMINOUS ROADS!

Type "DX" Spreader-Finisher



Powerful 20' machine, "re"-mixes and spreads as well as finishes the black top. Meets the demand for a bigger production machine (up to 1500 tons daily) to operate on forms or cu b—produces finest, smoothest riding roads ever laid.

Robinson & Cooper, near Dayton, O., with 4-man crew, 107 degrees roadside temperature and 50 per cent of time spent waiting for trucks, ran 105 tons per hour. Brown & Root, Houston, Texas, are breaking records. Get the details.

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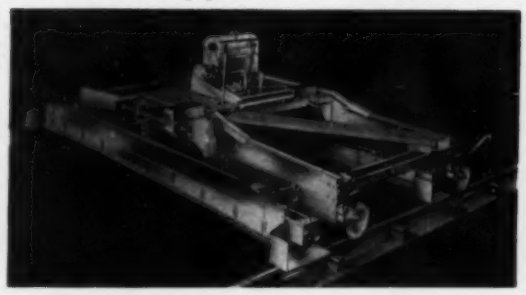
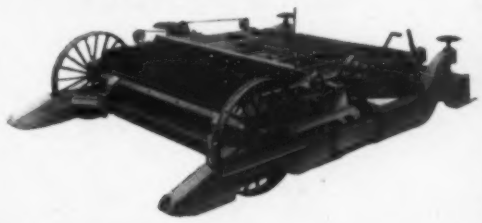
1935 Type "D" Finisher



Used throughout the world for concrete and higher type bituminous and concrete roads and streets, either hot or cold mixed—gives new smoothness of surface at lower costs. Inexpensive attachments make it suitable for wedge course, binder and top, either full widths to 30 ft. or half widths—10,000 sq. yds. per day on 20-ft. road. Valuable new features developed by Jaeger black top engineers such as special Asphalt Dolly replacing compression strips and extra workers—no rakers needed in front. Send for CATALOG BP-2.

ASK ABOUT OUR PORTABLE "SURE PRIME" PUMPS FOR WASHING OUT ASPHALT CARS!

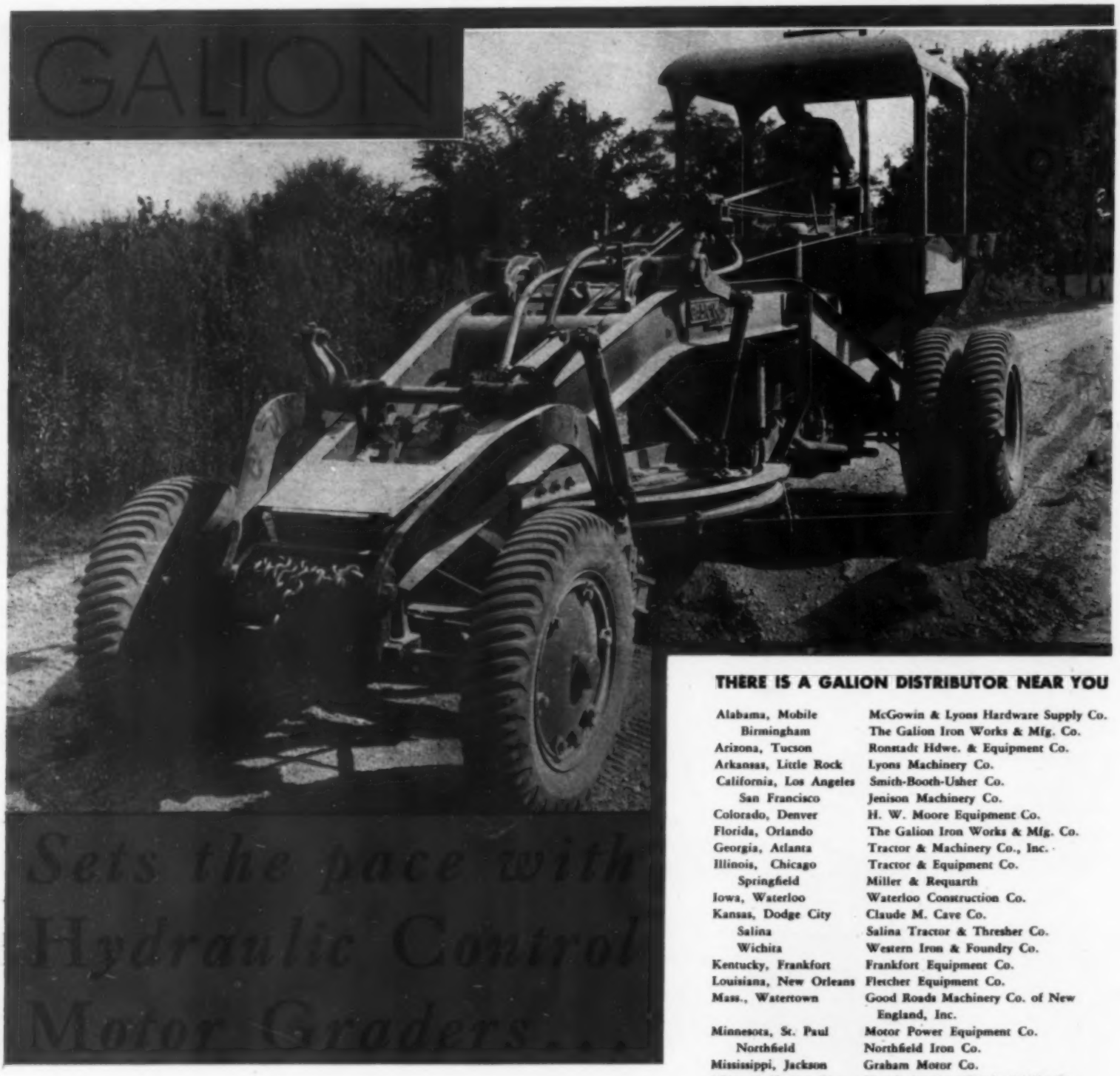
JAEGER VIBRO
BLACK TOP SPREADER
(Pulled by Truck)



A moderate priced machine. Where heavy trucks with special low speeds are available, this is most rapid spreading box ever offered for gravel, stone, slag, etc. Adjustable, oscillating, vibrated screed also lays binder and top—100 tons per hour are possible with new smoothness of surface and minimum of hand work.

Four wheels carry 70 per cent of load—reduce drawbar pull to minimum. Has features of long straight-edge equalizing runners, 1" to 7" spread with any crown and no weight or traction on newly laid materials, same as our power driven Bituminous Paver. Adjustable 9'—11' by means of blender screeds.

Two "Vibros" spreading crushed stone. Note perfect match between strips.



Galion Motor Graders with hydraulic control set a new record in efficient, speedy, economical road maintenance. The hydraulic operation takes all the labor out of adjustments. More miles are covered in a day because there is no time wasted in spinning wheels.

Three short range levers are conveniently located in front of the operator. A slight pressure forward or backward on these levers quickly and accurately adjusts the moldboard or scarifier to suit conditions.

In addition, other new features have been built into Galion Motor Graders to make them the sturdiest and most powerful ever built. No job is too tough for their rugged moldboard assembly and massive steel frame support. Abundance of power is supplied by either McCormick-Deering, Case or Oliver Tractors.

Galion Motor Graders can also be furnished with Patented E-Z Lift Manual Control, with Cletrac power in addition to the three mentioned above.

Investigate the advantages of Galion Hydraulic Control Motor Graders — NOW.

THERE IS A GALION DISTRIBUTOR NEAR YOU

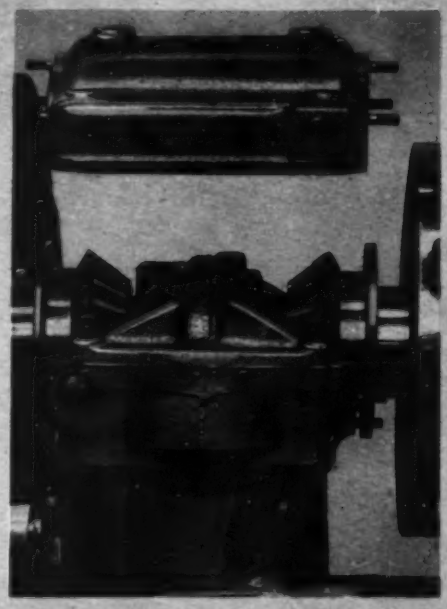
Alabama, Mobile	McGowin & Lyons Hardware Supply Co.
Birmingham	The Galion Iron Works & Mfg. Co.
Arizona, Tucson	Ronstadt Hdwe. & Equipment Co.
Arkansas, Little Rock	Lyons Machinery Co.
California, Los Angeles	Smith-Booth-Usher Co.
San Francisco	Jenison Machinery Co.
Colorado, Denver	H. W. Moore Equipment Co.
Florida, Orlando	The Galion Iron Works & Mfg. Co.
Georgia, Atlanta	Tractor & Machinery Co., Inc.
Illinois, Chicago	Tractor & Equipment Co.
Springfield	Miller & Requarth
Iowa, Waterloo	Waterloo Construction Co.
Kansas, Dodge City	Claude M. Cave Co.
Salina	Salina Tractor & Thresher Co.
Wichita	Western Iron & Foundry Co.
Kentucky, Frankfort	Frankfort Equipment Co.
Louisiana, New Orleans	Fletcher Equipment Co.
Mass., Watertown	Good Roads Machinery Co. of New England, Inc.
Minnesota, St. Paul	Motor Power Equipment Co.
Northfield	Northfield Iron Co.
Mississippi, Jackson	Graham Motor Co.
Missouri, Kansas City	The Galion Iron Works & Mfg. Co.
Maryland, Baltimore	Henry H. Meyer Co.
Montana, Butte	Hall Perry Machinery Co.
New Mexico, Albuquerque	Morrow & Co.
New York, New York City	Good Roads Machinery of N. Y., Inc.
Penn Yan	W. H. Stoutenburg
North Carolina, Raleigh	North Carolina Equipment Co.
Oklahoma, Oklahoma City	Herd Equipment Co.
Oregon, Portland	Feenaughty Machinery Co.
South Carolina, Columbia	South Carolina Equipment Co.
Tennessee, Nashville	Tennessee Tractor Co.
Memphis	W. D. Banker Road Machinery Co.
Texas, Houston	Browning-Ferris Machinery Co.
Dallas	Browning-Ferris Machinery Co.
San Antonio	Lewis Patten Co.
Utah, Salt Lake City	C. H. Jones Co.
Vermont, Barre	Casellini-Venable Corp.
Virginia, Richmond	Richmond Machinery & Equipment Co.
Washington, Seattle	Feenaughty Machinery Co.
Spokane	Feenaughty Machinery Co.
Wisconsin, Milwaukee	Badger Road Equipment Co.

IN CANADA

Quebec, Montreal	Jeffrey Mfg. Co., Ltd. of Canada
British Columbia, Vancouver	Brown-Fraser & Co., Ltd.
Ontario, Toronto	J. S. Innes, Ltd.

THE GALION IRON WORKS & MFG. CO., GALION, OHIO

Modern Bucyrus-Eries give long-life service



Where bevel gears are used for reversing the propelling and swinging motions, this simple, long-life construction is used on modern Bucyrus-Erie machines

When gasoline and Diesel excavators were first introduced, their life expectancy was far shorter than the old steamers they displaced. But step by step Bucyrus-Erie has built into modern excavators the long life and sturdy dependability for which their famous steamers were outstanding.

As you look over these up-to-date machines, at every point you see evidence of this long life construction. Look, for example, at these reversing bevel-gears for swinging and propelling. Note the ruggedness of the massive casting in which they are held in lasting alignment by large, long wearing ball-bearings. The entire assembly is completely enclosed and runs in oil.

When you compare balanced value, study the strength and endurance of this gear unit. Compare others with the dependable, long-life performance you can see in Bucyrus-Eries.

BUCYRUS-ERIE COMPANY
South Milwaukee, Wis.

781

Transforms the THUNDERING HERD *into* CONTROLLED ACTION...

ELECTRIC BLASTING *converts the tremendous horsepower force of explosives into* CONTROLLED ENERGY

Electric blasting insures unquestioned mastery of timing. Electric blasting makes possible the simultaneous firing of many charges. It permits testing of caps and circuits before, during and after loading.

Electric blasting causes the explosive to detonate at its normal rate, thus permitting the selection of an explosive with just the right velocity.

The consequence is that the user gets maximum yardage, favorable breakage or fragmentation, controlled back-break, and a controlled throw of rock to place it where it is wanted—with a maximum of safety and economy.

Let the Atlas representative show *you* how Atlas Electric Blasting provides the ultimate in control of blasting operations.

ATLAS POWDER COMPANY, WILMINGTON, DEL.

Cable Address—Atpowco

Everything for Blasting

OFFICES

Allentown, Pa.	Joplin, Mo.	New Orleans, La.	Pittsburgh, Pa.	Spokane, Wash.
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ATLAS

EXPLOSIVES

DO YOU KNOW

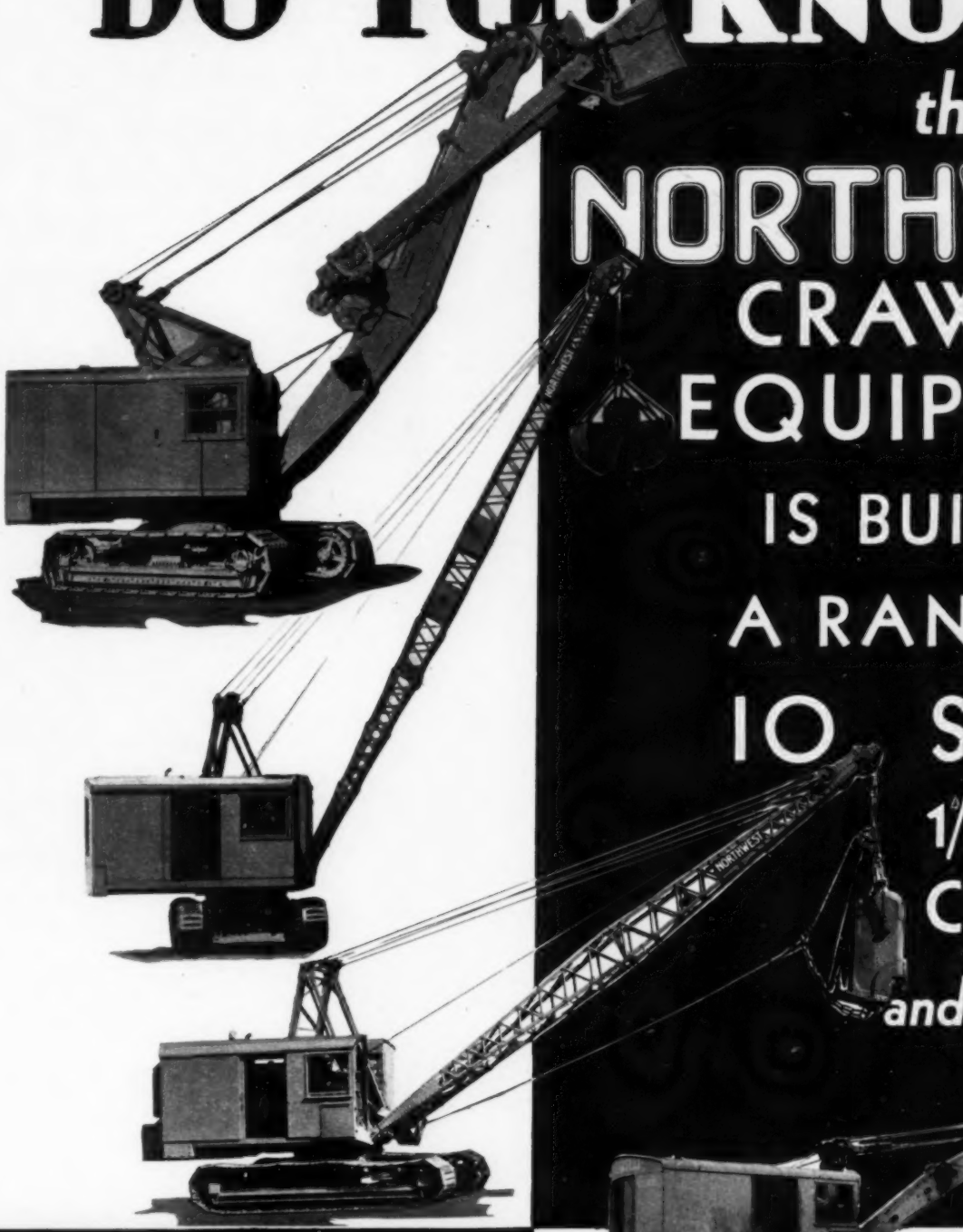
that

NORTHWEST CRAWLER EQUIPMENT

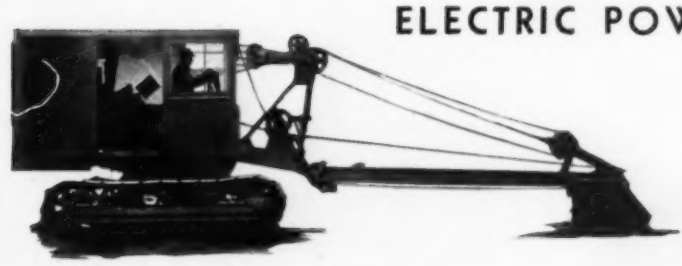
IS BUILT IN A RANGE OF

10 SIZES

1/2 CU. YD. CAPACITY *and* LARGER



GASOLINE, OIL, DIESEL OR ELECTRIC POWER



There is a size for every problem

NORTHWEST ENGINEERING COMPANY

1728 Steger Bldg., 28 E. Jackson Blvd.

Chicago, Ill., U. S. A.

The Colonial Construction Co., of Spokane, Washington, uses "Caterpillar" Diesel power in the construction of a new scenic highway in Rainier National Park.

On a fuel cost of less than a dollar a day, Amador County does road maintenance work with this "Caterpillar" Diesel Tractor near Jackson, California.

"THE 'CATERPILLAR' DIESEL TRACTOR HAS CUT OUR FUEL COSTS 70%"

—SAYS A COUNTY SUPERVISOR WHOSE ROAD WORK WAS FORMERLY DONE WITH A GASOLINE TRACTOR. OTHER OWNERS, EVERYWHERE, REPORT SIMILAR SAVINGS

"It costs only half as much to fill the fuel tank, and a tankful lasts twice as long"—"Fuel for our tractor costs less than food for the driver"—"Our big 'Caterpillar' Diesel costs less for fuel than three smaller gasoline tractors" . . . these are terms in which owners express their delight over the economy of the "Caterpillar" Diesel. For their economy—plus rugged power, sure traction and faithful performance—"Caterpillar" Diesel Tractors have won a foremost place on today's earth-moving, contracting, road-building jobs. They can reduce your power costs. Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

AMERICA GOES DIESEL

BLAW-KNOX ROAD BUILDING EQUIPMENT

MODERN EQUIPMENT—Always Kept Up to Date for Better—Faster and Cheaper Work

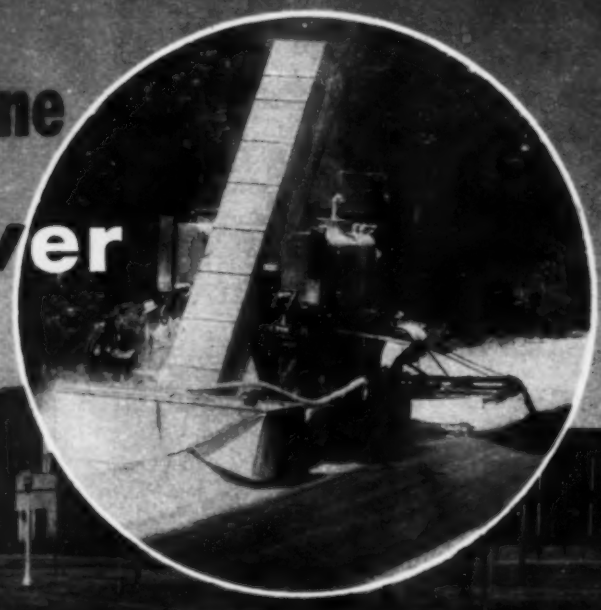
The merits of Blaw-Knox Construction Equipment are fully recognized by contractors who are able to "low bid" on competitive jobs, fulfill all specifications and end up with a reasonable profit.

BLAW-KNOX COMPANY 2086 Farmer's Bank Building, Pittsburgh, Pa.

Offices and Representatives in Principal Cities

"EADQUARTERS FOR CONSTRUCTION EQUIPMENT SINCE 1906"

Judge the Barber-Greene Bituminous Paver BY RESULTS



This is part of a 30 mile job laid in 1932. All of the proportioning and mixing were done by the Barber-Greene Bituminous Paver. On this portion, where the road was 74 feet wide, the B-G machine mixed and laid two windrows of material. The accurate proportioning and thorough mixing of the materials which included 200 mesh fines, accounts for the perfect condition of this road after two years of use.

Excerpts from Road Oil Congress Papers . . . . . .

"The travel plant method has had the approval of 15 state highway departments, together with the approval of such Federal aid officials as may have had jurisdiction in the various states."

"We have mixed with the travel plant* as much as 16,000' in 24 hours and in one instance we accomplished 32 miles in 256 working hours with one machine."

"With the calibrated opening or gate on the machine* any ratio of oil can be had instantly by adjusting the gate opening, thus compensating for varying absorptions as shown in the log of absorption tests taken previously from the aggregate windrow."

"The oil necessary for absorption per square yard of 3" cake ranged from 1.3 to 2.8 gallons on one job."

"We are much enthused with the machine* and the results obtained with it. We think it is the answer to many of our problems. Its use will not add any to the cost of mixing and many benefits are possible, such as the use of better binders, and more precise control of mixtures. Cutbacks can be used equally as successful as road oils. Also we consider the road equal to that obtained by Plant Mix at a very material saving in cost."

"Beginning with 1933 in Utah, new departures as to methods of construction are being adopted. To replace the mixing on the road with blade graders, there is coming into extended use two types of mixing machines both making use of the pug mill mixing principle: One is the stationary plant usually set up at the materials deposit, and used in connection with the ordinary crushing and screening plant; the other is a portable or traveller type of machine operated on the road. It now appears that the older methods of mixing by blade graders, except for the smaller isolated jobs, will be supplanted."

"Other advantages with the Travel Plant Method are continuation of traffic without interruption. No fresh oil for traffic to drive through. Oil is always kept at a uniform temperature which is one of the essentials in a good mix. There is no partially mixed material to become water-soaked from rain."

* *Barber-Greene Bituminous Paver.* 35-2

Four New B-G Bituminous Machines for 1935

IMPROVED PAVER — The B-G Bituminous Paver which has been building a constantly higher performance record will have many major improvements.

SMALLER PAVER — A new smaller Paver at less price and having less capacity than the larger machine — BUT retaining the same accuracy of proportioning, and the same thorough mixing that has proven to be invaluable on the larger Paver.

COUNTY MODEL PAVER - FINISHER — A combination of the smaller Paver, and a New B-G Finisher which gives the advantages of plant mix and machine finish on even the shortest jobs.

NEW FINISHER — Entirely New principle of self-levelling combined with tamped compaction gives the highest quality riding surface — and the longest road life. Finisher travels on sub-base and finished surface — not on shoulders. Finishes flush to curb or obstructions.

Barber-Green Built U. S. Mississippi River Finishers

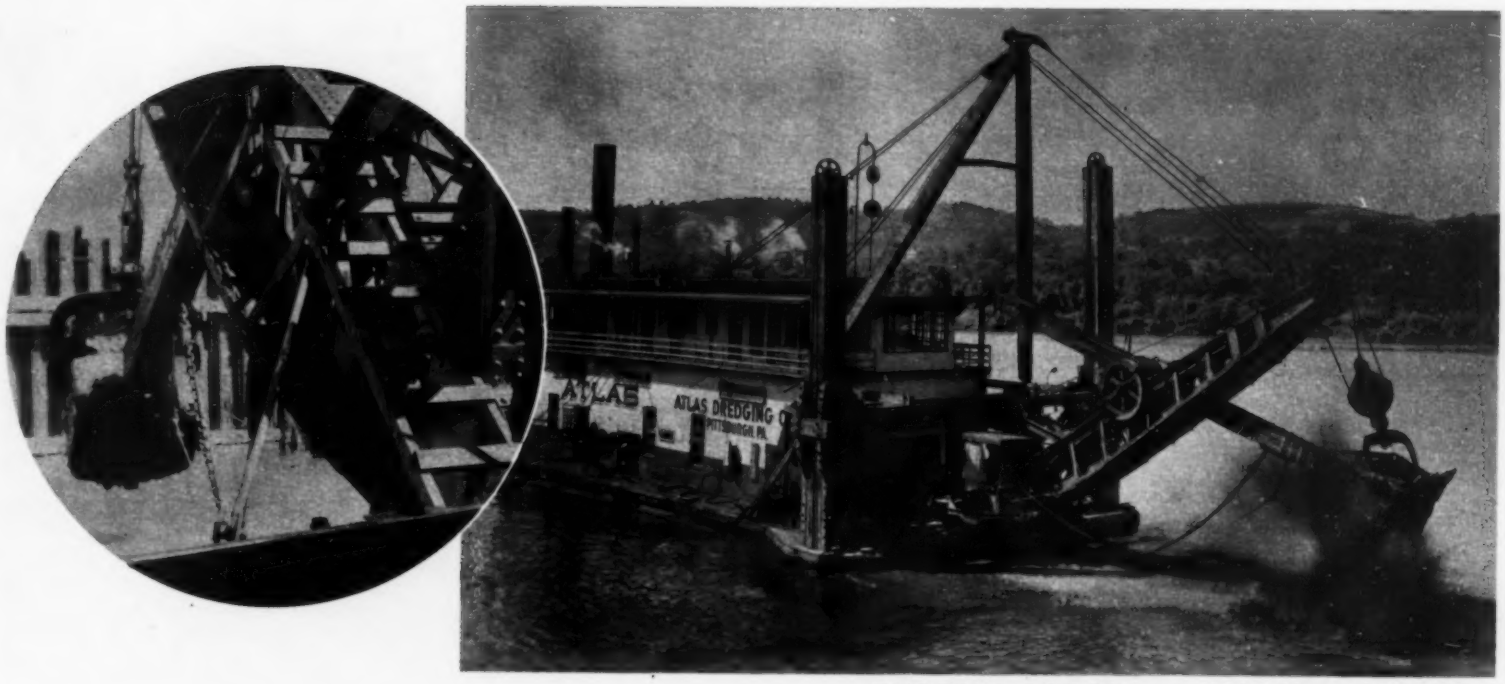
The 30' wide Finishers, which are now spreading and tamping the mats for the Mississippi River Revetment work, were designed and built by Barber-Greene. These machines are handling an extremely difficult sand asphalt mix including 400 mesh loess. Consult B-G about your bituminous plans and problems. Our experience together with the ingenuity which has been manifested in the many B-G Bituminous models warrent your confidence.

Standardized Material Handling Machines

BARBER GREENE

AURORA, ILLINOIS

MEET US AT THE ROAD SHOW



FIVE TONS OF BOOM . . . FIVE TONS OF BUCKET

This great dredge is operated by the Atlas Dredging Company on the Ohio River near Beaver, Pa., and is working on the Montgomery Dam. The four-yard bucket weighs five tons, the dipper stick weighs five tons and the boom weighs five tons. It moves 185 yards of dirt per hour.

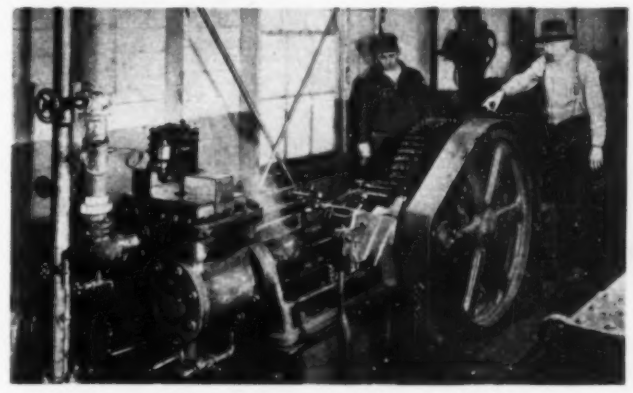
"GULF LUBRICANTS GIVE ME LOWEST MAINTENANCE COSTS"

Says Mr. Charles Zubik, Owner, Atlas Dredging Co.

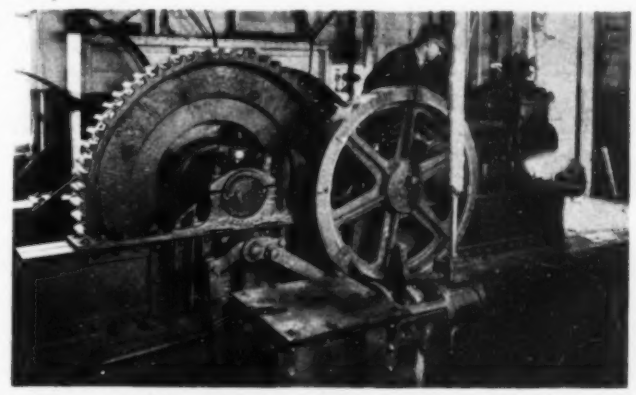
THIS CONTRACTOR makes the definite statement that Gulf lubricants are most economical for him to use *because they keep his equipment operating at lowest cost.*

The *real* measure of lubrication cost is maintenance and repair costs. Leading contractors in all types of construction work are adopting Gulf lubrication for the ultimate economies which result from its use.

Your equipment can be kept continuously on the job with fewer shut-downs and lower maintenance expense by following the recommendations of a trained Gulf engineer. He will inspect your machinery and recommend from Gulf's complete line of quality lubricants exactly the right type of oil or grease for each requirement. This service is given without charge. If you are not using Gulf products, let us demonstrate.



Gulf Lubecote clings to the gears on this engine, which turns the boom on the dredge. Cylinders, valves and all moving parts are protected with the right Gulf lubricants to keep this unit in continuous operation.



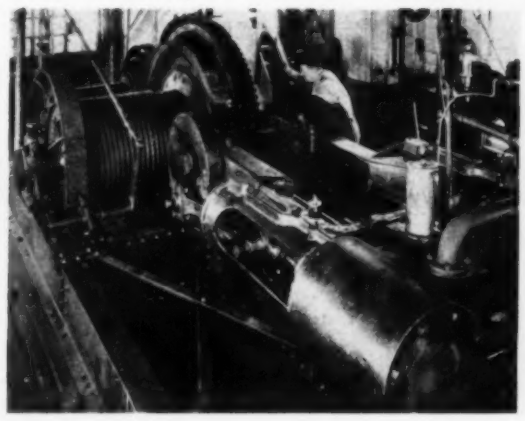
This engine is used for raising and lowering the spuds which anchor the dredge. Gulf oils and greases of the proper grades protect cables, gears and cylinders.

GULF REFINING COMPANY, PITTSBURGH, PA.

District Sales Offices

Boston · New York · Philadelphia · Atlanta · New Orleans
Houston · Pittsburgh · Louisville · Toledo

GULF INDUSTRIAL LUBRICATION



This two cylinder engine is the main power unit on the dredge. The use of Gulf products has kept costs at a minimum for this unit.

Gulf Refining Company
3800 Gulf Bldg.,
Pittsburgh, Pa. CM-1

I would like to have information regarding lubricants for

.....

.....

Name .....

Title .....

Company .....

Address .....

DETROIT PUBLIC LIBRARY

TWO CHAMPION

AGAIN FOOTE LEADS THE WAY

—With a new finer Adnun Black Top Paver incorporating many new developments and advantages that bring still greater economy—still greater profit to the contractor with a Black Top problem. On the new Adnun greater accuracy is assured by improved cutter bar design. Control has been centralized. Ground pressure has been lowered. Wheel design has been improved. Operation is simpler and easier, and a new power cut-off assures a saving of material and facilitates ease in handling at the intersection.

There is no Black Top machine on the market that can equal the Adnun for speed and performance. Get the complete details at the Road Show, Booth 25.

The Adnun Black Top Paver brings you advantages unequalled by hand labor or other machines.

- It lays any mix, hot or cold.
- Lays any width.
- Lays any thickness.
- Crowns or banks road.
- Requires no forms or shoulder preparation.
- Assures an accuracy of surface impossible for hand labor.
- Makes a perfect joint between courses or between Black Top and concrete.
- Ties up the minimum number of pieces of equipment.

ADNUN *for* BLACK TOP

TRADE MARK REGISTERED

THE

The World's

S OF THE ROAD!

AN UNBEATABLE COMBINATION FOR SPEED!

For years the MultiFoote paver has led the field. Today the MultiFoote brings you the last word in advantages for the laying of concrete slab.

It offers you an unbeatable combination for speed.

The streamline skip is steep and clean as a whistle—no place here for material to build up.

The "no pressure" water tank puts the water in the drum at the right time without delay.

Because of its design the double cone drum gives a better mix and its scouring action eliminates building up, a big advantage with early strength cements.

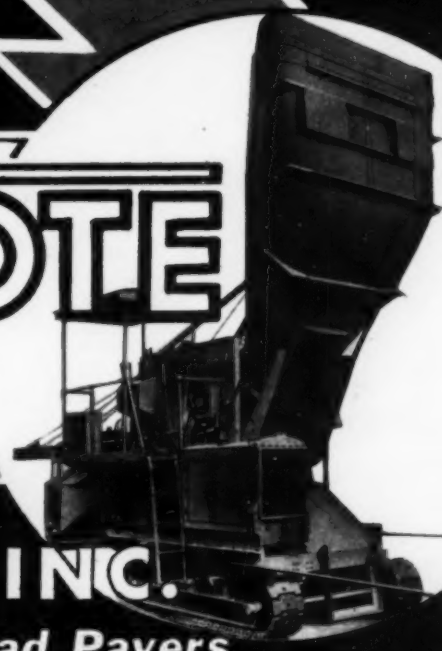
The Power Operator assures the instantaneous action and perfect synchronization that comes with power operation.

The boom swings by power and the bucket design eliminates drip.

Complete this with an engine that assures plenty of power for all operations and the MultiFoote Traction that takes the MultiFoote anywhere.

If you have a concrete road job in prospect you should have complete information on the latest MultiFoote. See us at the Road Show.

Foote engineers have kept pace with concrete road problems. The Foote Company specializes in paver design and improvement and is not influenced by the sale of or adaptation of parts to other types of machines.



MULTIFOOTE
for Concrete

FOOTE COMPANY, INC.

Largest Exclusive Builders of Road Pavers

NUNDA, NEW YORK

KOEHRING

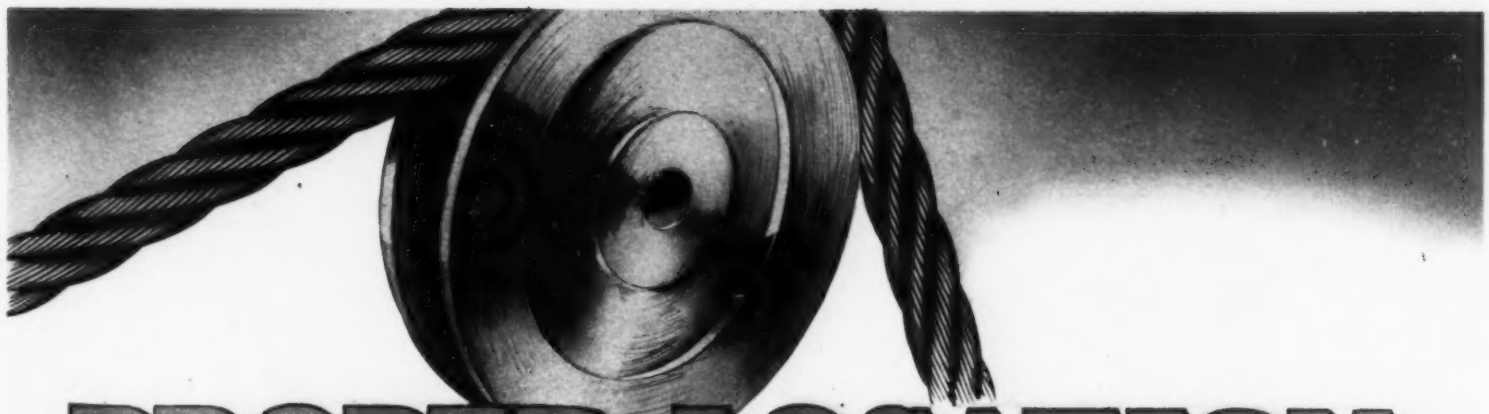
The New Koehring 801 Shovel

— is convertible to crane or dragline — furnished with gasoline, diesel, oil or electric power—independent and positive, chain or cable crowd — sturdy, high strength welded shovel boom — Koehring hydraulically cushioned clutch and the exclusive Koehring boom foot shock absorber . . . For more details and specifications—

write for the new 801 bulletin.

KOEHRING COMPANY

MILWAUKEE *Division of National Equipment Corporation* WISCONSIN



PROPER LOCATION of the MAIN SHEAVE will give longer ROPE LIFE

Know your Ropes

...This is a helpful hint, how to make wire rope last longer. Subsequent Wickwire Spencer advertisements in this publication will give other dollar saving information. Tell us about your rope problem and we will give you the answer.

The fleet angle, that is, the angle formed by lines drawn from the main sheave to both right and left rims of the hoisting drum should never be more than 3 degrees. If there is a greater angle needless side wear of the rope always occurs. This is true of both grooved and smooth drums. The condition when found may be corrected by increasing the distance between the main sheave and the drum. Diagrams, showing the proper location of the main sheave, will gladly be sent to you upon request.

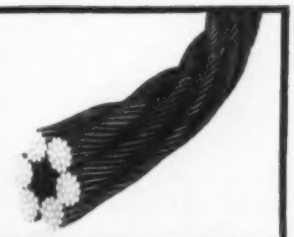
•

WICKWIRE SPENCER STEEL COMPANY, New York City; Buffalo, Chicago, Worcester; *Pacific Coast Headquarters:* San Francisco; *Warehouses:* Portland, Los Angeles, Seattle. *Export Sales Dept.,* New York City.

WIRE ROPE *by Wickwire Spencer*

BOTH...STANDARD LAY AND WISSCOLAY PREFORMED.

Wickwire Spencer manufactures all sizes and types of Wire Rope in standard lays and preformed. Wisscolay preformed wire rope will often solve a wire rope application difficulty. Ask our engineers where and when it should be used. Send for a free WIRE ROPE BOOK. It will prove of great value.



CB-38

There's more on the RIGHT SIDE

Let's look at both sides of the Cordeau question.

Cordeau-Bickford is an insensitive *detonating* fuse. It consists of a lead tube filled with trinitrotoluene (TNT), which when detonated with a fuse cap or E. B. Cap carries a powerful detonating wave to all parts of the blast. This wave travels at a speed of approximately 3 miles per second.

Like any equipment, the profit-making power of Cordeau is in what it may save you — in time, labor, hazard. If you can use giant blasts, for instance, there should be no question about the benefits of Cordeau: they outweigh first costs to such an extent that the Cordeau-detonated giant blast is rapidly becoming standard practice wherever possible.

There are, however, five *general* advantages which can be weighed against practically any blasting operation. Give each of these any value you choose; you are the best judge of that:

More work from your explosives. This is because each cartridge will have the added force of a primer cartridge.

Simplified loading. No primer cartridges to be prepared. Only one connection to be made at each hole.

Less hazard. Cordeau is an insensitive detonator.

Equipment moved less often. Bigger shots are possible, with less interruption in clearing, drilling.

Better fragmentation. Shots can be planned precisely to give you good digging, easier removal.

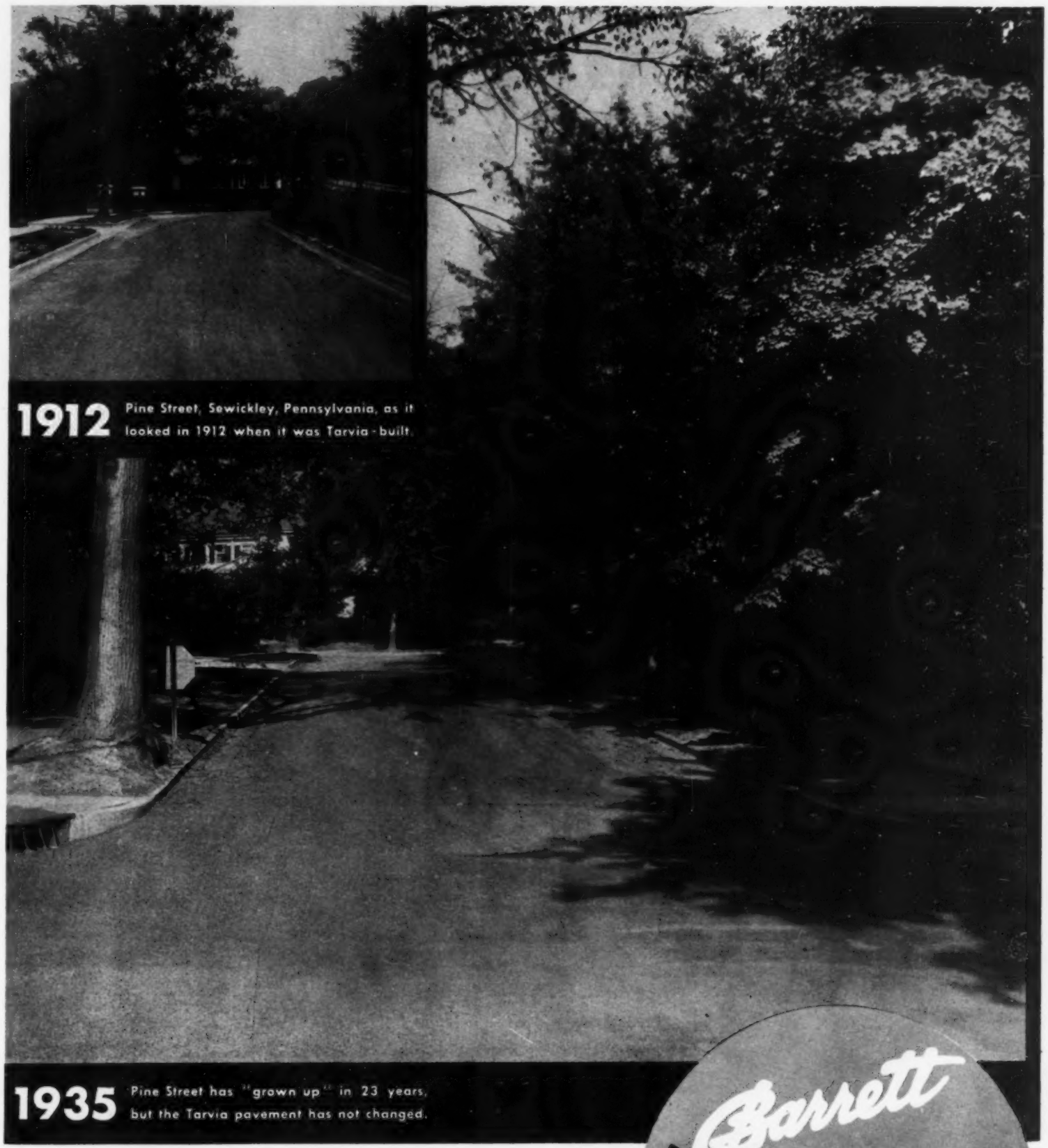
We don't wish to over-sell you, but we do suggest that you look into this subject. Others have found the use of Cordeau very profitable. Send for the Cordeau book. The Ensign-Bickford Co., Simsbury, Conn. *Estab. 1836.*

CORDEAU
DETONATING FUSE
BICKFORD

ALSO SAFETY FUSE *Since* 1836

THE ENSIGN-BICKFORD COMPANY

1912 Pine Street, Sewickley, Pennsylvania, as it looked in 1912 when it was Tarvia-built.



1935 Pine Street has "grown up" in 23 years, but the Tarvia pavement has not changed.

The Barrett Company Tarvia organization, with its 31 years of successful experience in low-cost road-building, offers practical, money-saving cooperation to road officials, particularly those whose 1935 budgets are limited. Before completing your plans, talk them over with a Tarvia field man. He can show you how to meet immediate and future needs inexpensively — how to get the most miles of smooth, easy-riding, skid-safe road . . . Meet us at Booth 34 Annual Meeting of American Road Builders Association, Willard Hotel, Washington, D.C., January 22-24, 1935.

Barrett
Tarvia
GOOD ROADS AT LOW COST

THE BARRETT COMPANY New York Chicago Philadelphia Birmingham St. Louis Rochester Toledo Milwaukee Detroit Baltimore Youngstown Cincinnati Buffalo Minneapolis Syracuse Bethlehem Providence Cleveland Hartford Portland, Me. Lebanon Columbus Boston In Canada: THE BARRETT COMPANY, LTD. Montreal Toronto Winnipeg Vancouver

"SHE'LL PAY FOR HERSELF

★

A perfect slope and as smooth as a grader can make it when taking a cut this size.

★

AUSTIN-WESTERN No. 11 GRADER

on this Job!"

REPORTING HOW PHILLIPI BROS., MINNEAPOLIS CONTRACTORS, FEEL ABOUT THEIR INVESTMENT IN A No. 11 GRADER, AFTER OPERATING OTHER TYPES.

The "feel" of a road grader doing a job under his hands is important to the operator. The "feel" of the investment by the owner watching and wondering whether it will pay out is also significant as a guide to other contractors and highway commissioners.

Here is the comment of Phillipi Brothers after a new Austin-Western No. 11 Road Grader had been put to work—and notice how it covers both the operator's and the owner's viewpoint:

"She sure is a peach, and do you know what we like most about it? It's the curvature and the way the blade is hung. . . . It seems to handle lots more dirt easier than anything we've ever had. The dirt rolls out over the front of the blade, but it is not rolled around sharply so that a binding action results. We had a ____ 12-foot on the job while we were waiting for yours and I never realized there could be that amount of difference in a grader. I've been under the impression that a blade is something made to push dirt around that is hung from a frame on wheels but the Austin-Western changed my mind after seeing it work. There isn't a doubt in my mind that she'll pay for herself on this job."

The "difference" detected in this case should suggest a possible advantage on your work. Send the coupon for an illustrated bulletin with full details.

The Austin-Western Road Machinery Co.
Home Office: Aurora, Ill. Cable Address: AWCO, Aurora
Branches in Principal Cities

Smoothing out the roadway where rocks and boulders (some too heavy for a man to lift) were thrust to the side, as shown above.

The curvature of the blade and its position on the frame makes the full load of dirt roll clear without binding.

ROAD GRADERS · MOTOR GRADERS · ELEVATING GRADERS · DRAGS

ROAD ROLLERS

Austin-Western

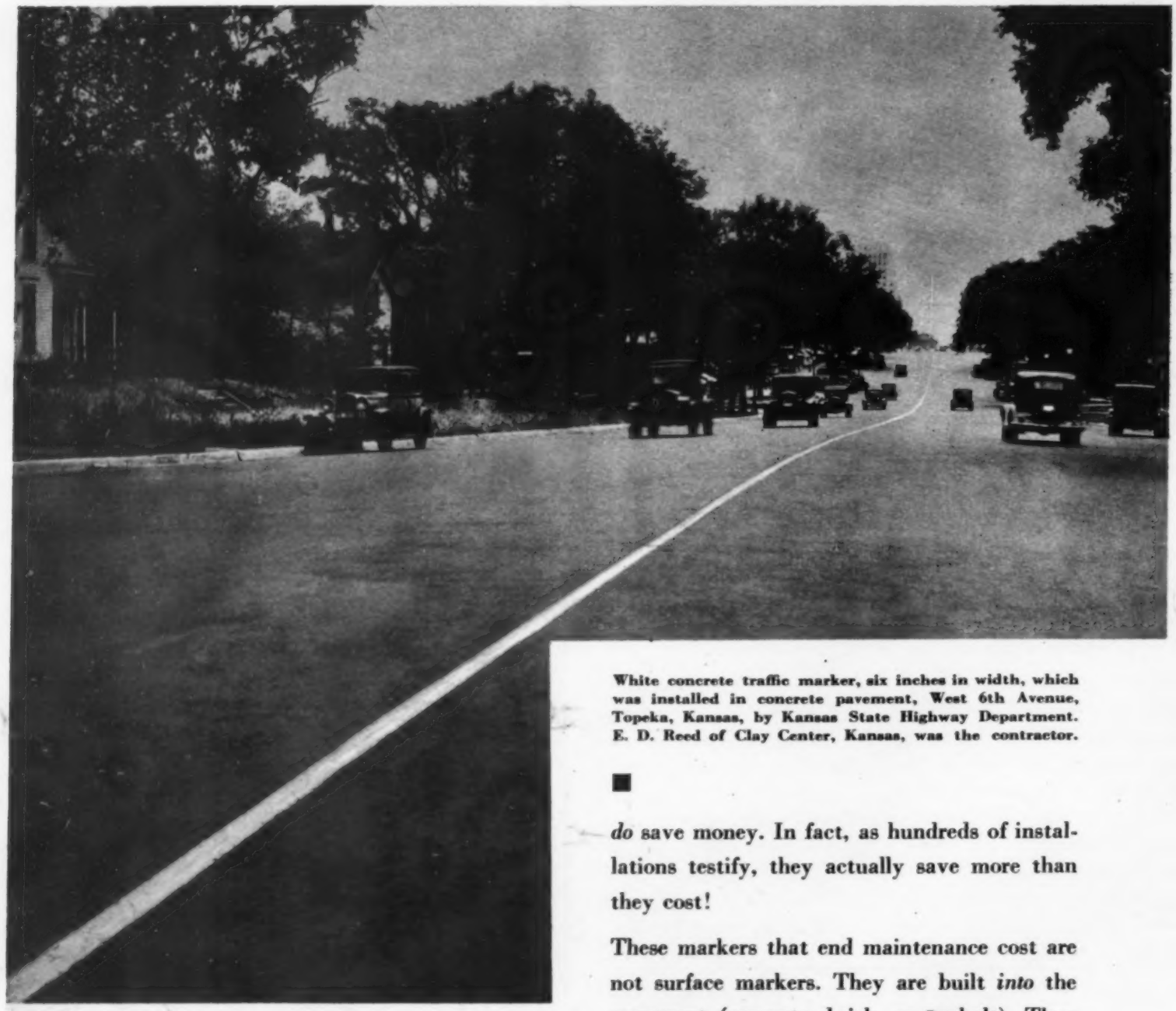
DUMP WAGONS

BITUMINOUS DISTRIBUTORS · ROAD-MIX MACHINES · CULVERTS
SCARIFIERS · BULLDOZERS · TRAILERS · SCRAPERS · PLOWS
DUMP CARS

CRUSHING AND WASHING PLANTS · SWEEPERS AND SPRINKLERS · SHOVELS · CRANES · ETC · SNOW PLOWS

The Austin-Western Road Machinery Co.
A-6, Aurora, Ill.
Please send detailed information on Austin-Western Road Graders.
Name.....
Address.....
City ..... State.....

End MARKER MAINTENANCE



White concrete traffic marker, six inches in width, which was installed in concrete pavement, West 6th Avenue, Topeka, Kansas, by Kansas State Highway Department. E. D. Reed of Clay Center, Kansas, was the contractor.

■

SAVING money on maintenance is not the only reason why white concrete traffic markers are installed. But it is the most important.

No matter how good they look, no matter how much time and trouble they save, no matter how much more effective they are, if these permanent white markers did not save money, their installation would be less important. But they *do* save money. In fact, as hundreds of installations testify, they actually save more than they cost!

These markers that end maintenance cost are not surface markers. They are built *into* the pavement (concrete, brick, or asphalt). They are built of solid white concrete. They are finished to a dense, hard, impenetrable white surface. They resist traffic stains and weather stains. No replacement is ever necessary. They *stay* white.

Write for complete, money-saving information on traffic markers to Universal Atlas Cement Co., Subsidiary of United States Steel Corporation, 208 South La Salle Street, Chicago.

ATLAS WHITE TRAFFIC MARKERS

171

Made with Atlas White Portland Cement—Plain or Waterproofed

Construction Methods

NRA CODE

ROBERT K. TOMLIN, Editor

Established 1919—McGraw-Hill Publishing Company, Inc.

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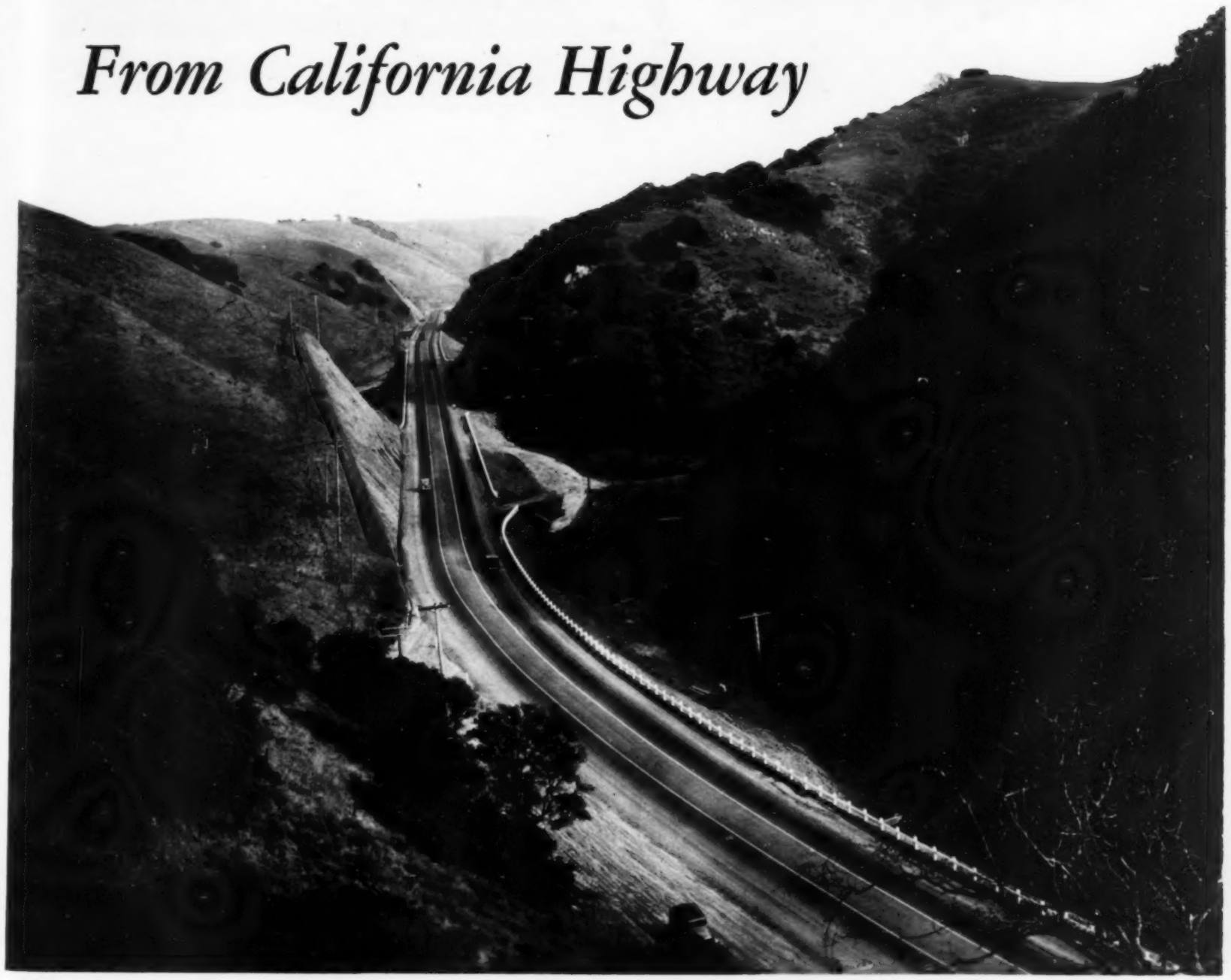
REALIGNMENT *Removes Kinks From California Highway*



REALIGNMENT of California State Highway Route 5, by speeding traffic in Dublin Canyon, Alameda County, has provided a short cut from the San Francisco Bay region to the San Joaquin valley. Previously the route through the canyon involved a total curvature of 998 deg. and had curves of 500-ft. radius. The new route, 6.7 mi. long, has only 376 deg. of curvature and the sharpest curve has a 1,000-ft. radius. The new route is graded to a width of 46 ft. and paved with portland cement concrete 40 ft. wide. The sharpest summits provide a clear sight distance of 600 ft. Traffic had to be maintained while the new route was being built, a difficulty which will be appreciated from the fact that in the 6.7-mi. length the new location crosses the old road seven times, as indicated in the accompanying sketch.

This Month's "NEWS REEL"

MEMBERSHIP CUP of Associated General Contractors is won by Vermont chapter. Burt L. Knowles *(right)*, chairman of A.G.C. membership committee, presents James E. Cashman trophy to C. A. Brown, president of Vermont chapter, at banquet in Burlington, Vt.

FIRST TOWER *(above)* at Queen's end of Triborough Bridge's 1,380-ft. suspension span, near famous Hell Gate railroad arch, New York City, is topped out with erection of 25-ton top chord member 270 ft. above ground. Taylor-Fichter Steel Construction Co., Inc., of New York City, erects 4,500 tons of tower steel for Triborough Bridge Authority, O. H. Amman, chief engineer, with guy derrick on independent steel staging. Tower is 98 ft. wide, c. to c. of legs. Similar tower at Ward's Island end of span has since been topped out by same contractor.

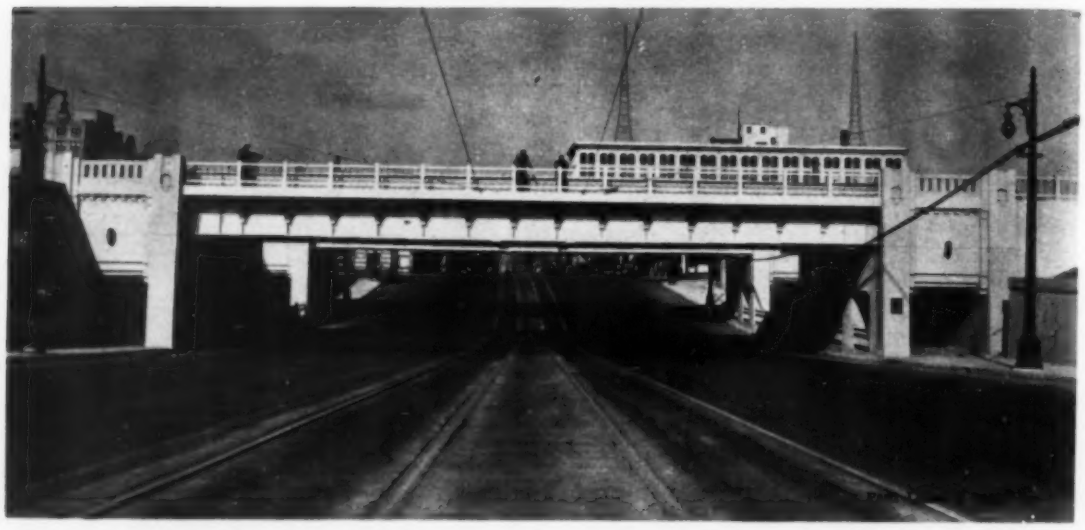
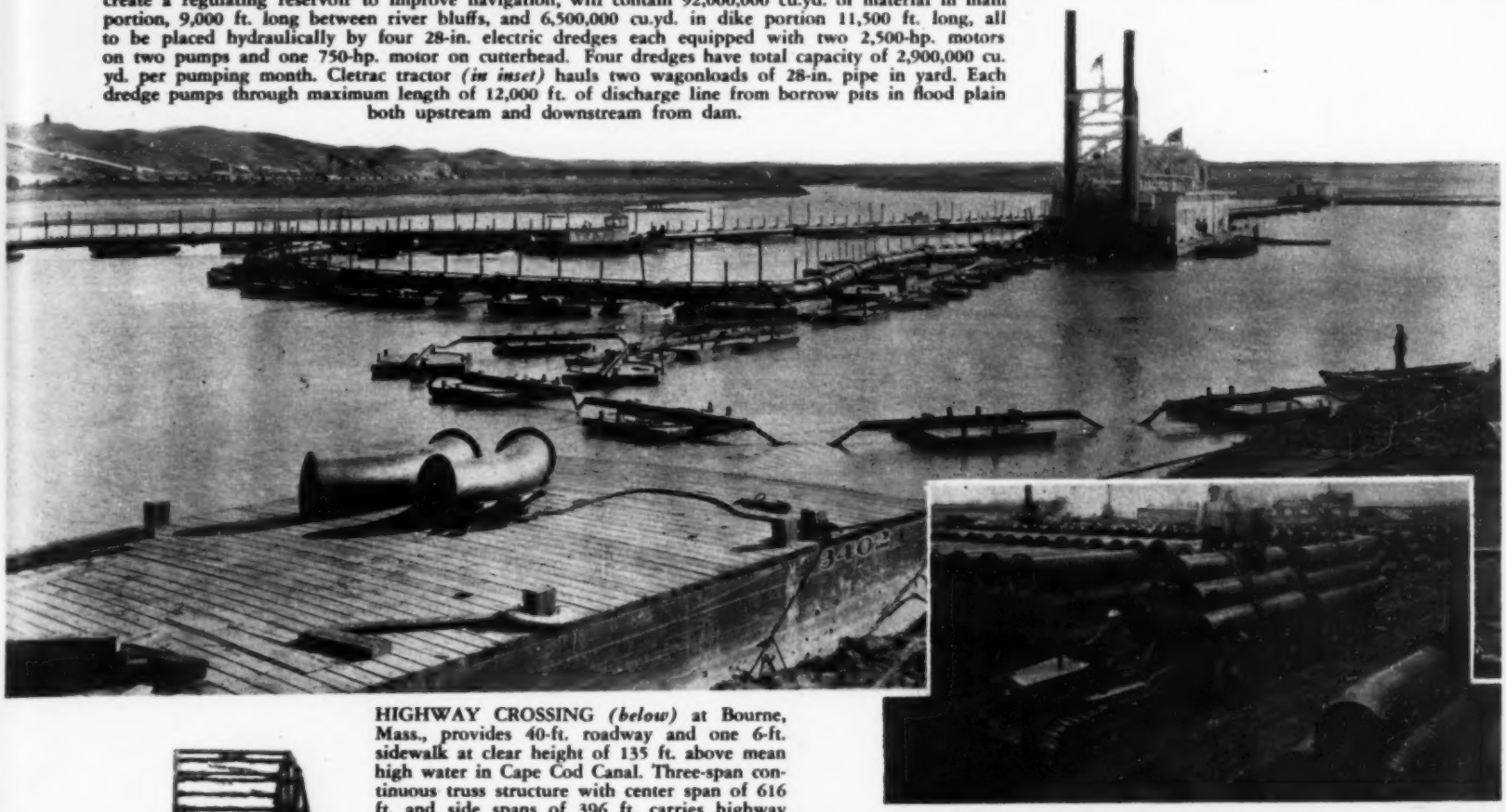


PLATE GIRDER BRIDGE of 95½-ft. span, carrying five railroad tracks across Woodward Ave., Detroit, replaces old 54-ft. structure and permits widening of street from 50 to 90 ft. between curbs, as described elsewhere in this issue. D. W. Thurston Co., Detroit, contractor for Michigan State Highway Department.

INSPECTION PARTY sees 12-cu.yd. Monighan walking dragline leave erection yard of W. E. Callahan Construction Co., Gunther & Shirley to start excavation for U. S. Bureau of Reclamation on All-American canal to carry Colorado River water to Imperial Valley, Calif. *(Left to right)* R. C. E. Weber, superintendent, Yuma Project; J. C. Thrailkill, chief clerk, E. J. Westerhouse, field engineer, and R. B. Williams, construction engineer, All-American Canal; Herman Gunther, of W. E. Callahan Construction Co., Gunther & Shirley; Henry Frauenfelder, president, Yuma Valley Water Users' Association; Bruce Gentry, engineer, W. E. Callahan Construction Co.; T. J. Madden, assistant district counsel, Bureau of Reclamation; T. A. Clark, office engineer, All-American Canal; and R. J. Coffey, district counsel, Bureau of Reclamation.

FORT PECK HYDRAULIC-FILL DAM on upper reaches of Missouri River, in Montana, designed to create a regulating reservoir to improve navigation, will contain 92,000,000 cu.yd. of material in main portion, 9,000 ft. long between river bluffs, and 6,500,000 cu.yd. in dike portion 11,500 ft. long, all to be placed hydraulically by four 28-in. electric dredges each equipped with two 2,500-hp. motors on two pumps and one 750-hp. motor on cutterhead. Four dredges have total capacity of 2,900,000 cu. yd. per pumping month. Cletrac tractor *(in inset)* hauls two wagonloads of 28-in. pipe in yard. Each dredge pumps through maximum length of 12,000 ft. of discharge line from borrow pits in flood plain both upstream and downstream from dam.



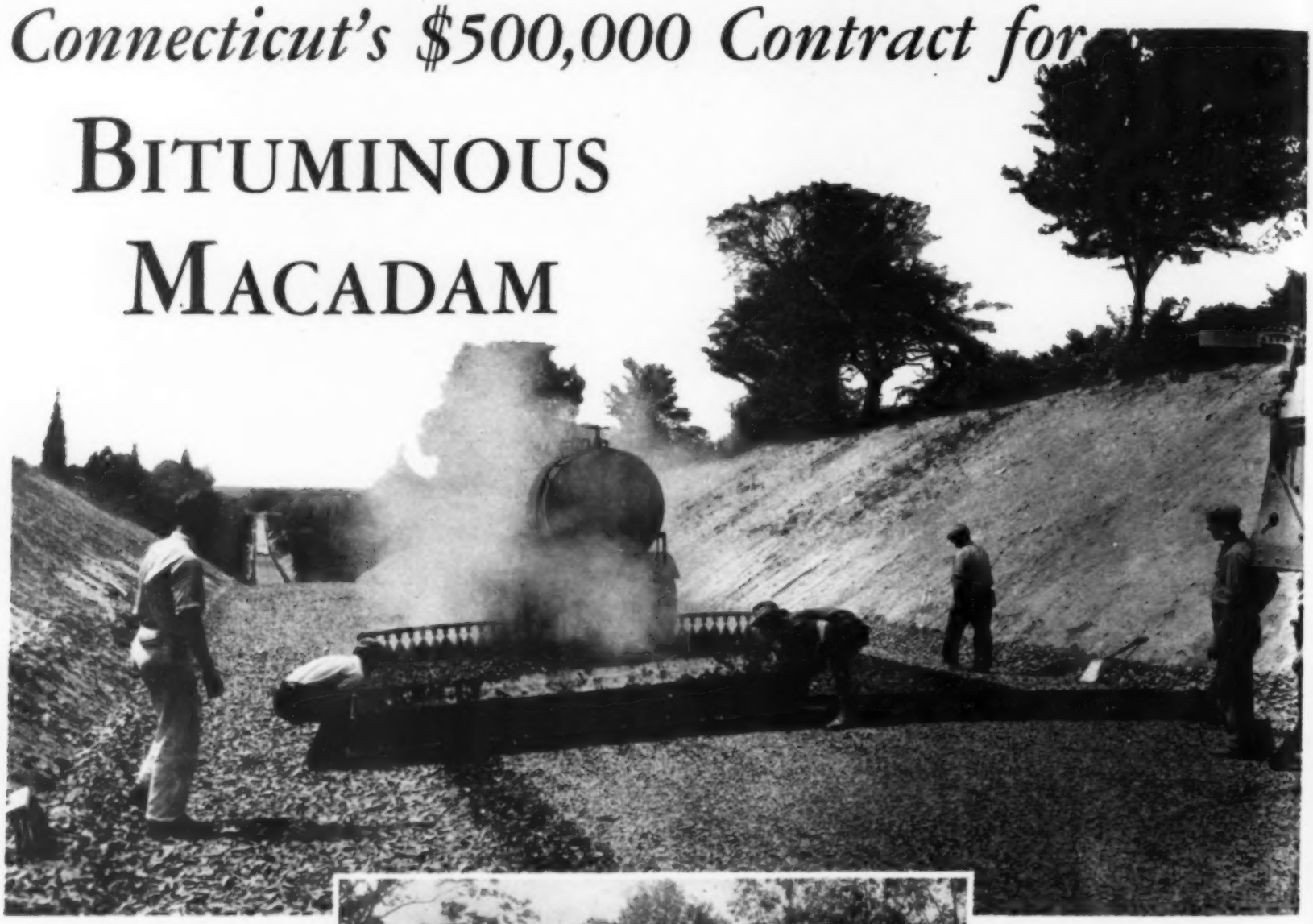
HIGHWAY CROSSING *(below)* at Bourne, Mass., provides 40-ft. roadway and one 6-ft. sidewalk at clear height of 135 ft. above mean high water in Cape Cod Canal. Three-span continuous truss structure with center span of 616 ft. and side spans of 396 ft. carries highway across canal. Foundations were constructed by C. W. Blakeslee & Sons, New Haven, and Blakeslee-Rollins Corp., Boston, under arrangement with P. J. Carlin Construction Co., of New York, contractor. American Bridge Co. is contractor for superstructure.

GOVERNMENT RAILROAD 34½ mi. long is completed and put into service to site of Grand Coulee dam, where contractor, The Mason-Walsh-Atkinson-Kier Co., is preparing plans for steel bridge to carry railroad across Columbia River. Straight track crosses alkali wastes to where it drops down steep slopes to river bank at Grand Coulee, 92 mi. west of Spokane, Wash.

FIRST FEDERAL HOUSING PROJECT IN MIDWEST starts with demolition of 274 Cleveland slums to make way for $3,000,000 proposed construction. *(Left to right)* James Ruble, federal housing project manager; Councilman Ernest Bohn; Col. Roger Black (with glasses), special representative of Public Works Administrator Harold L. Ickes; George L. Sogg, and Councilman Hubbard. Emergency Housing Corporation of PWA is financing and directing work.

Connecticut's $500,000 Contract for

BITUMINOUS MACADAM



PRESSURE DISTRIBUTOR applies hot asphalt to stone surface. Troughs (in foreground) are placed at start of travel and removed when machine operates at full pressure, to insure uniform application.

BOX SPREADER behind motor truck distributes stone in two 3¼-in. layers for a 6½-in. base course.

ON THE LONGEST single contract for bituminous macadam road construction ever let by the Connecticut State Highway Department, an 11½-mi. section costing approximately $500,000 and extending in a northeasterly direction from Preston City (5 mi. east of Norwich) to Beach Pond, at the Rhode Island state line, the Lane Construction Corp., of Meriden, Conn., last season employed for the first time on heavy road grading operations in New England the large capacity (12-cu.yd.) pneumatic-tired "carryall" type of tractor-hauled scraper recently developed and used extensively on the Pacific Coast. The project involved the relocation and reconstruction of routes Nos. 165 and 138, old earth roads, 12 to 16 ft. wide on the line between Norwich, an industrial center 12 mi. north of New London, and Providence, R. I.

Road Design—The road, as rebuilt, has a 20-ft. width of bituminous penetration surfacing with a fairly flat crown of 2¼ in., and 5-ft. oiled shoulders on each side. The design specifies a 9-in. thickness of crushed stone of two sizes and two degrees of hardness, placed in three courses—two 3¼-in. base courses of native 3-in. stone and a 2½-in. top course of 2-in. traprock shipped to the job from a point west of the Connecticut River, as no traprock is available in the eastern part of the state. Stone for the base course, with a specified limit for the percentage of wear of 5.5 as against 3.3 per cent for the harder top-course material, is obtained and crushed by the contractor at two quarries adjacent to the work.

Where the subgrade material encountered is soft, unstable or otherwise unsuitable a gravel sub-base 1 ft. thick is built and compacted by rolling with a 10-ton roller to provide adequate drainage and support for the superimposed 9-in. thickness of crushed stone forming the pavement. In all rock cuts, however, the thickness of the gravel sub-base is increased to 2 ft. and, where wet conditions obtain, rubble drains are laid along one or both sides of the road. Approximately 33,000 cu.yd. of gravel fill sub-base was used on this project. In all cuts where the gradient is 4 per cent or greater, bituminous surface gutters are employed.

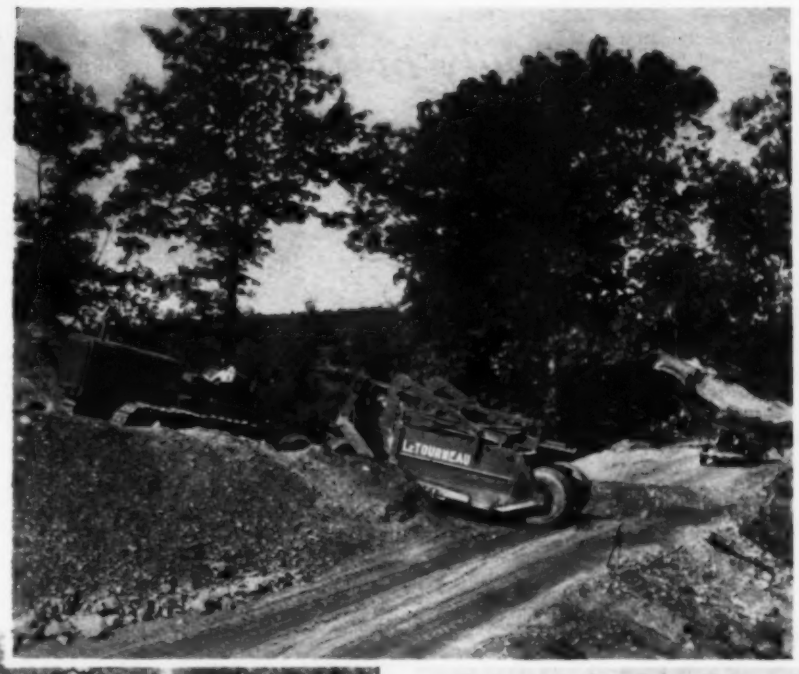
Heavy Grading Equipment—For the 11½-mi. length of the job the amount of grading required averaged about 4 cu.yd. per linear foot of highway. Estimated quantities in the contract included approximately 200,000 cu.yd. of earth excavation, 36,000 cu.yd. of rock excavation and 213,000 cu.yd. of fill. For moving this amount of material the Lane organization, under the direction of its superintendent, E. A. Gordon, mobilized a fleet of 9 power shovels varying in size from ½ to 1½ yd., 2 Le Tourneau 12-yd. carryall scrapers hauled by diesel-powered tractors, 10 bulldozer outfits, 1 truck crane, 2 wagon drills, and several portable air compressors. In addition to the regular trucks serving the power shovels there were two Linn tractor-type trucks powered by diesel engines.

While the contract involved rock ledge cuts at four points, requiring drilling with wagon drills and blasting, about one-third of the earth excavation was sufficiently free from boulders or ledge to make possible the efficient use

of the carryall scrapers. On the sections where obstructions were present in the subgrade, however, excavation was handled by the power shovels, but during the course of the work a total of about 70,000 cu.yd. was dug and moved by the two carryall scraper outfits. Based on the unit price for earth excavation on this contract—45¢ per cubic yard—it was found that the tractor-scraper units could be used economically on hauls up to 2,800 ft. Beyond that limit power shovels and trucks proved to be the cheaper method. The contractor unclassified earth and rock in bidding 45¢ per cubic yard for each.

Carryall Scrapers—Hauled by a 75-hp. diesel tractor the carryall scraper, weighing 15,450 lb. with its power control unit, has a welded steel carrying bowl 9x10 ft. in plan, with vertical sides 4 ft. high, holding 12 cu.yd. of material. It is mounted on six wheels equipped with large 13.5 x 50-in. low pressure pneumatic tires, two on the front end and four, in pairs, at the rear. The machine has a wheelbase of 17 ft. and axles of 4¾-in. heat-treated alloy steel. On the front or open end of the scraper bowl is a cutting blade ¾x10 in. by 10 ft. long.

The bowl is filled by tilting its front end downward into digging position through power control mechanism regulated by the tractor operator. After the scraper has moved forward until its bowl is filled the cutting edge is raised clear of the ground and the load hauled to the dumping point. Dumping is accomplished by means of a vertical steel plate which is pulled forward within the loaded carrying bowl by cables from the power control unit, pushing the load of earth out in front and spreading it in a layer of a few inches uniform thickness. From his seat on the tractor one operator controls all operations of hauling, loading and dumping. The machines can make a complete turn in a radius of only 15 ft.

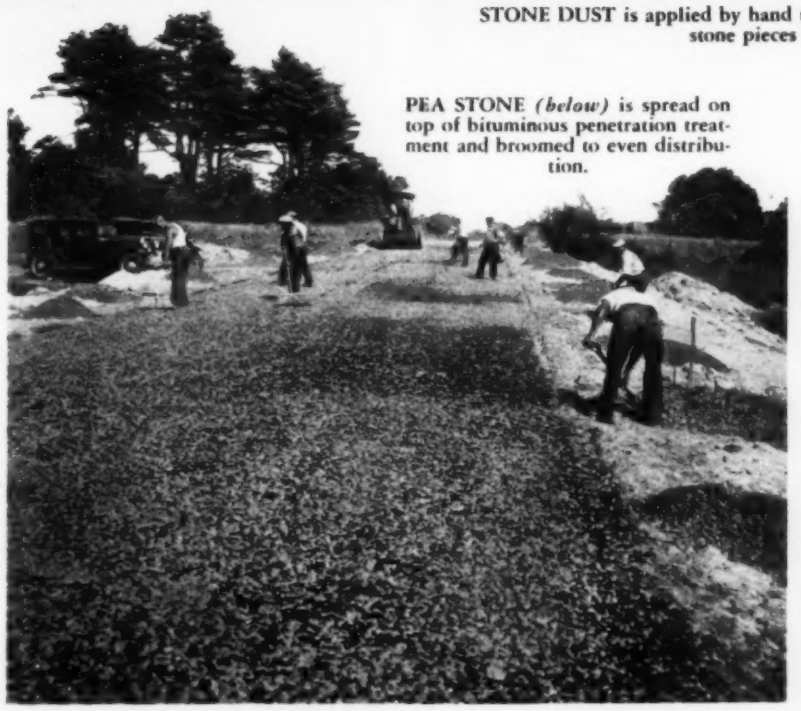


CARRYALL SCRAPER *(right)* of 12-cu.yd. capacity, hauled by tractor, does heavy grading.

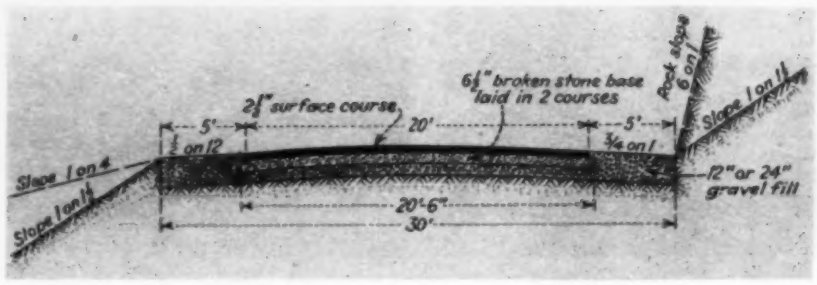
Broken Stone Base—Upon the completed subgrade of earth or gravel fill 3-in. stone for the 6½-in. thick base course is deposited in two layers of equal (3¼-in.) thickness by spreading devices attached to the rear ends of motor trucks. The first layer is thoroughly compacted by a 10-ton, 3-wheel roller before the second layer is spread and similarly rolled. Specifications for the base course, or Grade C, stone require 100 per cent to pass a screen with 3-in. square openings and not more than 15 per cent to pass 1⅜-in. square screen openings. The per cent of wear for the base-course stone must not exceed 5.5 and the toughness must be not less than 6.0.

ANOTHER TYPE of stone spreader has adjustable blades for distributing material across width of subgrade.

STONE DUST is applied by hand to base course to fill voids and bind stone pieces under roller.



PEA STONE *(below)* is spread on top of bituminous penetration treatment and broomed to even distribution.



CROSS SECTION *(right)* of Connecticut bituminous macadam pavement on gravel fill.

Upon each layer of the base course filler material in the form of stone dust (preferably), or sand, is spread in thin layers lengthwise of the road, sprinkled and rolled until the voids in the coarse material are filled and the stone pieces become solidly keyed.

Just before the bituminous penetration work is started the surface of the base course is thoroughly swept, hand labor being required for this operation by NRA regulations.

Upon the base course thus prepared the 2½-in. top course of hard 2-in. traprock is spread. Specifications for top course, or Grade A, stone require 100 per cent to pass 2-in. square screen openings and not more than 15 per cent to pass 1¼-in. square screen openings. The per cent of wear must not exceed 3.3 while toughness must be not less than 12.0. The 2-in. traprock for the top course is spread and rolled, sufficiently to key the stone. When completed and ready for the application of bituminous material, the top course presents open surface voids throughout.

Bituminous Surfacing—The final step in the construction is the penetration of the top course with two appli-

cations of hot asphalt (85-100 penetration) sprayed on to the surface by 1,500-gal. tank-truck pressure distributors. The first application, at the rate of 1¾ gal. per square yard, is covered with ¾-in. traprock screenings broomed in and rolled. Then follows a seal coat, of the same grade of asphalt, applied at a rate of ¾ gal. per square yard and covered with ½-in. traprock screenings thoroughly broomed and rolled to complete the surface. Where possible the full 20-ft. width of the highway is sprayed in one operation. Where spraying in half-widths is done it has been found difficult to prevent a certain overlap and, consequently, "fat" areas along the center line of the highway.

In starting the bituminous spraying operation a long metal trough is placed under the nozzles of the distributor and a small amount of the hot asphalt is wasted by discharge into this receptacle in order to insure operation at full pressure and uniform application of the required quantity per square yard as the distributor truck starts its journey over the stone top course.

Asphalt for the bituminous macadam construction is delivered by rail in tank cars at Jewett City, a distance of about 5 mi. from the central point of the job, and is heated by steam coils to a temperature of from 200 to 250 deg. F. before transfer to the insulated tanks of the pressure distributor trucks. In the distributor trucks the asphalt is raised to the required temperature en route to the job. Application to the road surface is at temperatures ranging from 275 to 350 deg. F.

The distributors are equipped with pumps driven by separate gasoline engines on the rear ends of the truck, and are equipped with tachometer devices to insure the application of the hot asphalt to the road surface at the desired rate per square yard. When applying the asphalt the trucks operate at a speed of from 1 to 3 mi. per hour. Interchangeable spray bars of several different widths are carried by each distributor truck, but except where half-width construction is necessary a 20-ft. spray bar is used, covering the full width of the roadway and preventing the inevitable overlap where spraying is done in two or more narrow strips.

Shoulders and Gutters — The roadway is finished with 5-ft. oiled shoulders on each side. The oiling is done by the maintenance forces of the state highway department using a short spray bar from a distributor truck.

In cuts on 4 per cent or steeper grades the road is provided with bituminous-surfaced gutters. These slope away from the edge of the highway at a rate of ¾ in. per foot for a distance of 5 ft. and then rise abruptly at the rate of 6 in. per foot to form a V-shaped trough for the removal of surface water. One of the pictures illustrates this detail. Ordinarily these gutters are constructed in the same manner as the road surface except that they are penetrated with asphalt using a hand spray fed by a hose line from a distributor truck, as illustrated in one of the photographs.

Labor — Under NRA regulations, which governed the construction of this highway, common labor was limited to a maximum employment of 30 hr. per week and had to be recruited from local labor employment offices. The policy adopted by the Lane Construction Co. was to employ each worker on a single shift of 10 hr. for a period beginning on Thursday mornings and ending the following Wednesday nights. This arrangement brought 3 of the days worked into one week and the succeeding

A Study in Textures

BASE COURSE STONE *(below)* before rolling. Hat indicates comparative size of pieces.

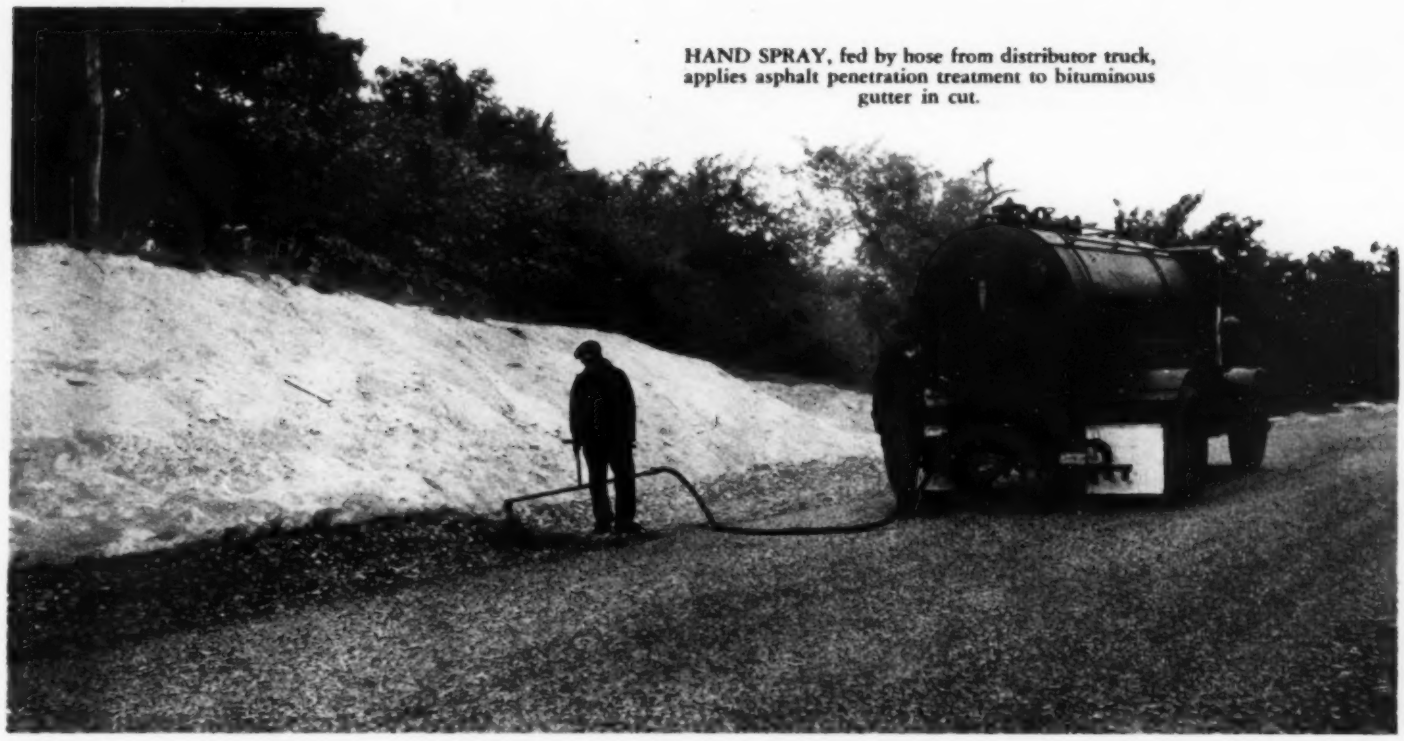
STONE DUST FILLER *(below)* is broomed in and rolled to bind base-course stone.

FINISHED SURFACE of pavement before traffic has removed excess pea stone.

TEXTURE OF PAVEMENT after surface has been subjected to traffic.

10-TON ROLLER consolidates base-course stone as stone-dust filler is applied for binding.

TWO-LANE CONSTRUCTION permits traffic to use half of road while top-course stone on other half is penetrated with hot asphalt.



HAND SPRAY, fed by hose from distributor truck, applies asphalt penetration treatment to bituminous gutter in cut.

3 days into the following week. After 6 days of continuous employment on this basis each laborer was laid off for one week and then reemployed the following week.

The reason for this plan was dictated by local conditions. The construction is located in a sparsely populated country region and as most of the available workers resided in Norwich or other towns some distance from the job it was necessary for them to board at farm houses close to the work or else drive back and forth daily from their homes. By working only on alternate weeks each man's bill for board and lodging was reduced or, if he traveled to work by car from his own home, the expense of gas and oil for the round trip was incurred bi-weekly instead of weekly.

When the job was in full swing the daily shift employed averaged 275 men, with a peak employment of 374 men per shift. Under the conditions that existed with regard to recruiting labor from local unemployment relief lists there was a considerable turnover in the contractor's personnel. A large percentage of the workers sent out by the local labor agencies were young men, many just out of school, who had not worked before. Others, mostly from textile mills and other industrial plants at Norwich, were without construction experience. A third group came from some of the camps of the Civilian Conservation Corps where their terms of enlistment had expired in August; these young men were found to be in good health and well hardened physically for road building work. Most of the former textile mill workers from Norwich who applied for jobs on the road found it difficult to adapt themselves to construction duties outdoors and often left the work after only a few hours of service. It was Superintendent Gordon's experience that to obtain a working force of about 500 men a total of 1,900 applicants had to be examined and given a trial. Always it was necessary to carry an excess of 8 or 9 men to fill vacancies created by sudden defections from the ranks of the contractor's force.

E. A. GORDON, superintendent for Lane Construction Corp., contractor.

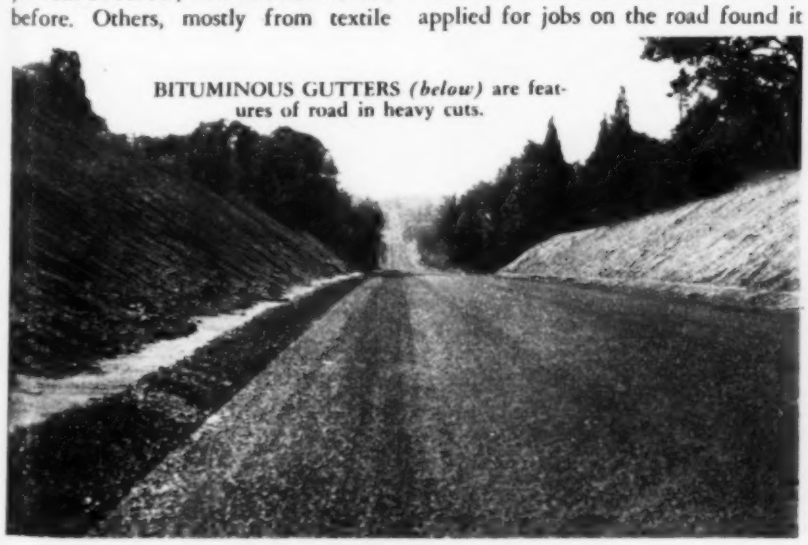
L. H. BEEBE, resident engineer of construction for Connecticut Highway Department.

Physical Examination — One policy that the contractor found well worth while was insistence upon a physical examination by its own doctor before putting a man on the payroll. This was done primarily to avoid accidents on the job by barring men physically unfit to engage in duties, such as loading stone or lifting heavy weights, that might injure them. One result of this preliminary sifting out of applicants was that during the course of the entire job not a single case of hernia developed.

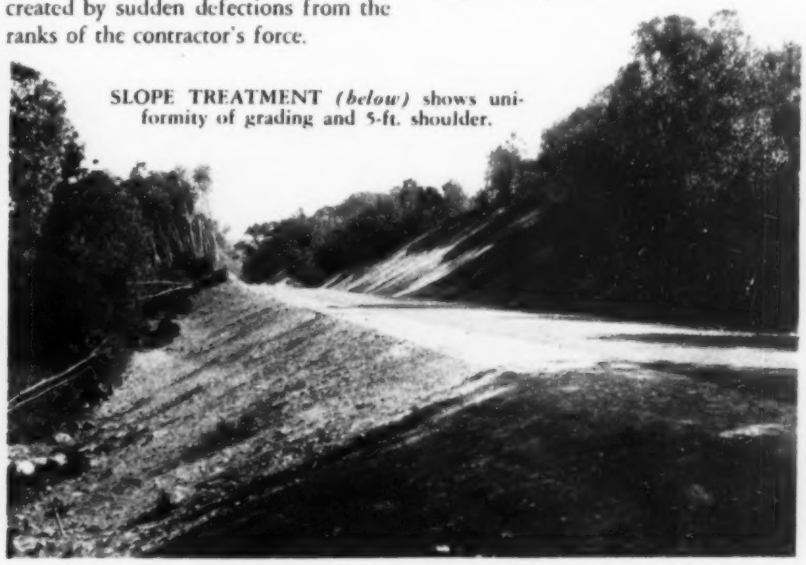
Personnel—The building of the Preston-Beach Pond bituminous macadam highway was under the immediate supervision of L. H. Beebe, resident engineer of construction, with A. M. McKenzie serving as chief inspector. In general administrative charge of this and other construction for the Connecticut State Highway Department was A. W. Bushell, engineer of contracts and construction, reporting through E. C. Welden, deputy highway commissioner, to Commissioner John A. MacDonald.

For the Lane Construction Corp., of Meriden, Conn., E. A. Gordon was in charge as superintendent.

BITUMINOUS GUTTERS *(below)* are features of road in heavy cuts.



SLOPE TREATMENT *(below)* shows uniformity of grading and 5-ft. shoulder.



PNEUMATIC-TIRED BOTTOM-DUMP TRAILER hooked up to truck-tractor is loaded from end of 48-in. belt on power-controlled elevating grader.

FLEXIBLE GRADING OUTFIT

Builds 5 Miles of Fills

AS THE FIRST step in closing the only remaining gap in U.S. 50 across the state of Indiana, J. C. O'Connor & Sons, Inc., of Fort Wayne, under the direction of the state highway department built 5¼ mi. of fills containing 430,000 cu.yd. of material, employing for this work a versatile battery of earth-moving units comprising oil tractors, gasoline tractors, power-controlled elevating graders, track wagons, pneumatic-tired trucks (both end-dump and bottom-dump), and one large carryall scraper. While this array of equipment was moving earth at an average rate of 6,000 yd. a day from ten borrow pits into fills where the material was bladed, disked and rolled in layers, the Vincennes Bridge Co. under separate contract on the same project was erecting eight bridges of several types and varying dimensions. After the fills have settled through the present winter, the state highway department plans to pave the project in the spring and open the completed link to traffic early in the summer.

Details of Project—Extending 6 mi. west of Brownstown, Ind., the project crosses the wide bottom lands of the White River, which are flooded each spring. To put the new pavement beyond reach of spring floods and at the same time provide passages for the flood waters, the highway department designed 5¼ mi. of fills averaging 9 ft. high with a 650-ft. steel truss bridge across the White River, two concrete-pile overflow bridges 200 ft. and 400 ft.

IN CHARGE OF WORK. *(Left to right)* R. H. Harrell, project engineer for Indiana Highway Department; A. D. Blackburn, resident construction engineer for J. C. O'Connor & Sons, Inc.; Ray Arwine, foreman; Orville Sweet, foreman; and J. J. Dressel superintendent.

WIDE SHALLOW BORROW PITS at ten places along 5¼ mi. of fills produce 400,000 yd. of material from excavation not exceeding 4 ft. in depth.

long, and five concrete bridges over streams and ditches in the bottom lands. In addition the project includes an overhead structure crossing a Baltimore & Ohio single-track line. This bridge was built under separate contract by the Aden Steel Co., of Bloomfield, Ind. The approaches to the railroad overhead required the deepest fill, 27 ft. high.

Width of the fills varied at the top from 36 to 40 ft., depending on the height, with an average top width of 38 ft. Side slopes were 1 on 2. The maximum curvature of the highway is 3 deg., and the only grade of importance is a 6.7 per cent upgrade about 500 ft. long, entering Brownstown from the west.

Borrow and Fill—Of the 430,000 cu.yd. of excavation required by the

TRACTOR-DRAWN BLADE strikes off dumped loads of earth to 9-in. loose depth for compaction by roller.

PNEUMATIC-TIRED 12-YD. SCRAPER drawn by 75-hp. diesel tractor picks up load for transportation to fill. Traveling speed of this unit is about 5 m.p.h.

O'Connor contract, 396,000 yd. had to be obtained from borrow pits leased by the contractor. Arrangements were made for ten pits, so spaced as to afford about one pit for each ½ mi. of fill. These pits yielded 32,000 to 75,000 yd. each. The material was almost exclusively a sandy loam which was readily excavated, dumped and compacted.

To eliminate pools of standing water adjacent to highways, Indiana now specifies that borrow pits be drained, except in the few cases where they may be designed for use as storage reservoirs or lakes. The drainage requirement limited the depth of borrow to 4 ft. or less on this contract. Shallow excavation also was desired by the owners, who intend to farm the pits again after the spring floods have deposited a fresh layer of silt.

In one borrow pit on the O'Connor job, the landowner obtained permission to construct an artificial lake. The contractor accordingly excavated to a depth of 6 ft., going below the sandy loam into a gravelly blue clay which balled and stuck to the elevating graders and hauling equipment. Of 70,000 cu.yd. removed from the pit, about 10,000 yd. consisted of the less desirable material.

Fill material was dumped, bladed and disked in loose layers 9 in. deep, in accordance with specifications, before being compacted by 10-ton rollers. The O'Connor contract, which included all the small drainage structures in the fill, amounted to $134,076.75, and the total value of the work on the 6-mi. project was about $375,000.

Earth Movers—Because of the distribution of the borrow pits, it was necessary to work as many as three balances or portions of them from the same pit. The contractor therefore determined upon the use of a relatively slow tractor-and-wagon outfit for the work immediately adjacent to the borrow pit and a fast outfit to take care of the fill which required longer haul. Work performed by the several outfits was balanced as closely as possible to enable them to complete their operations at the same time. This dovetailing of the earth-moving operations proved difficult but worked out with a satisfactory degree of success on the O'Connor operations.

Most of the earth-moving equipment was propelled and operated by a battery of fourteen Allis-Chalmers and Caterpillar tractors ranging from 75- to 15-hp. capacity, driven by oil-engine, gasoline-motor or diesel power plants. Of eight 75-hp. units included in the group, five were oil-engine tractors, one was diesel-equipped, and the remaining two were gasoline driven. These tractors performed the heavy duties of drawing elevating graders, tandem track wagons, large-capacity scrapers, and big blade graders. Among the smaller hauling units, one oil-engine tractor of 45-hp. drawbar capacity served general utility purposes, and two 15-hp. units pulled fresno scrapers used in finishing.

Two power-controlled elevating graders drawn by 75-hp. oil-engine tractors loaded the sandy loam into wagons and trucks in the borrow pits. One excavator was an Allis-Chalmers unit with a 48-in. loading belt, and the second was an Austin-Western machine with a 42-in. belt. Both excavators were equipped with individual power plants

DISK-HARROW behind blade grader breaks up lumps in dumped material for more homogeneous consolidation in fill.

TANDEM-WAGON TRAIN hauling total pay load of 10 cu.yd. drops material to be spread by blade grader approaching from distance. Oil-engine 75-hp. tractor draws two loaded wagons at speed of 7 m.p.h.

HEAVY TRACTOR-DRAWN BLADE AND ROLLER level and consolidate material in layers. Practically all material is sandy loam, which compacts readily into solid, homogeneous fill.

which operated hydraulic controls of the disk plows and of three points on the belt.

Ten hauling units were loaded by the elevating graders. Five of these units were tandem-wagon trains made up of two Western track wagons (hauling 5-cu.yd. of pay load each) drawn by a 75-hp. tractor. The remaining five consisted of four Hug end-dump trucks (carrying a load of 4 yd. of pay dirt) and a Euclid Trac-Truk drawing a pneumatic-tired bottom-dump trailer with a pay-load capacity of 6 cu.yd. In addition to the hauling equipment loaded by the elevating grader, the contractor operated a LeTourneau 12-yd. carryall scraper drawn by a 75-hp. diesel tractor.

Operation and Results — Average haul from the point of loading to the point of dumping was about 850 ft. for the tractor outfit and about 1,600 ft. for the truck outfit. The several types of equipment operated with varying efficiency on hauls of different lengths, and the contractor distributed the hauling units as skillfully as circumstances permitted to obtain maximum yardages. Ordinarily the two elevating graders and the 12-yd. scraper worked the same borrow pit. The scraper outfit, with a maximum speed of about 5 mi. per hour, was held where possible to a hauling range not exceeding 500 ft. A speed of 7 mi. per hour could be obtained with the tractor-drawn tandem-wagon outfits, and these units were considered most efficient on hauls of 800 ft. or less. The Euclid bottom-dump truck was capable of traveling at 15 mi. per hour, enabling it to operate with satisfying results at distances up to ¼ mi. Longer hauls were made by the Hug trucks, which had governors set at 35 mi. per hour.

Operating as closely as possible within these hauling distances, the entire outfit averaged 6,000 cu.yd. of compacted fill per 15-hr. day throughout the course of the heavy work. Much higher records were made by the entire outfit and by the individual groups and units on certain days. The best record for the whole plant in one 15-hr. day was 8,500 cu.yd. of pay fill. A greater quantity of earth could be moved with all elements operating under ideal conditions, as indicated by daily records for the various divisions.

END-DUMP TRUCKS with traveling speed (set by governors) of 35 m.p.h. transport 4-yd. pay loads on longer hauls averaging 1,600 ft.

In 15 hr., for example, the five tandem-wagon trains moved 760 loads, or 3,800 cu.yd. of pay earth. The four end-dump trucks and the bottom-dump truck hauled as much as 900 loads in a day, equal to at least 3,600 yd. of compacted fill material. Under exceptionally good conditions, the LeTourneau 12-yd. scraper moved 1,800 yd. in 15 hr. and demonstrated its capacity to average more than 800 yd. of pay dirt per day.

Administration—James D. Adams is chairman of the Indiana State Highway Commission and M. R. Keefe is chief engineer. Under Ray Bower, district engineer, Seymour, Ind., the grading work was directed for the state highway department by R. H. Harrell, project engineer. For J. C. O'Connor & Sons, Inc., the contractor, M. P. O'Connor, vice-president, maintained active contact and general supervision, with J. J. Dressel in charge of grading and A. D. Blackburn as contractor's resident construction engineer.

ELEVATING GRADER WITH 42-IN. BELT, equipped with power controls and drawn by 75-hp. oil-engine tractor, loads tandem-wagon trains rapidly with stiff clay encountered at bottom of borrow pit excavated to 6-ft. depth for artificial lake.

Ohio Builds Concrete Pavement in

ZERO WEATHER

IN ATMOSPHERIC temperatures running as low as 7 deg. below zero, Crist & Beatty, of Hamilton, Ohio, last winter laid concrete pavement on 1.328 mi. of state route 180, between Hamilton and Eaton, for the Ohio Department of Highways, and opened the slab to traffic 72 hr. after placing. High-early-strength cement, heating of aggregates and water, and adequate protection of subgrade and slab were the chief factors contributing to the success of the concreting and quick hardening at low temperatures. No difficulty was experienced in keeping the slab from freezing. Although progress was necessarily slower than in summer, the cost of the paving operation increased only about 12 per cent, according to the estimate of the engineer in charge.

Because the project was included in the state's emergency federal aid program, the contract had to be completed by Jan. 1, 1934. Work on the contract, which amounted to about $75,000, was started Nov. 20 and completed Dec. 31. The paving project consisted of 1.144 mi. of 9-7-9-in. concrete pavement 20 ft. wide and 0.184 in. of pavement 41 ft. wide. A gravel embankment to carry the roadway, which parallels the Miami River, had been in place about one year. Practically all settlement had taken place, and the embankment afforded an excellent subgrade for winter construction. Additional grading involved in the paving contract required about 20,000 cu.yd. of borrow. The maximum pavement grade was 1.12 per cent. Six stone and brush breaks were constructed at a cost of $12,000 to protect the highway embankment against erosion by the Miami River.

Concrete Ingredients—A 1:5½ concrete mixture made up in the proportions of 6.3 cu.ft. of Incor high-early-strength cement, 11.78 cu.ft. of sand, 11.66 cu.ft. of No. 4 gravel and 11.21 cu.ft. of No. 3 gravel was produced in 1-yd. batches by a Multi-Foote 27-E paver traveling on the subgrade. Aggregates were heated by steam pipes running through the storage bins at a gravel plant about 1 mi. from the job. Sand and gravel left this plant at a temperature of about 110 deg.F. Water was heated at the mixer by a boiler resting on skids outside the forms. The paver pulled the boiler ahead. Temperature of the concrete when placed on the subgrade varied between 70 and 80 deg. F.

Subgrade and Slab — Subgrade was covered with about 2 in. of sand or granulated slag the day before placing concrete. On the following day, this cover was removed with a subgrader as needed. As the sand and slag were dry when placed, the paving crew had no trouble with the cover material's freezing. In several places the subgrade did freeze, but the crew found no difficulty in thawing these spots with hot water from the boiler. As the fill was gravel, this water seeped away rapidly and did not affect the subgrade.

Concrete was finished with a Blaw-Knox gasoline-electric finisher which also supplied current for night lighting. Contraction joints were installed from the deck of a Flex-Plane joint machine. In the time required for finishing and straight-edging, the concrete set sufficiently to permit covering with wet burlap. On top of the burlap, the contractor then placed 10 to 12 in. of straw.

Concrete Strengths—An average curing period of 3 days was employed, depending upon the modulus of rupture obtained in breaking a 6x6x40-in. beam. Results of these tests averaged 442 lb. per square inch at 48 hr. and 575 lb. per square inch at 72 hr. The pavement was opened when the modulus of rupture reached 500 lb. per square inch.

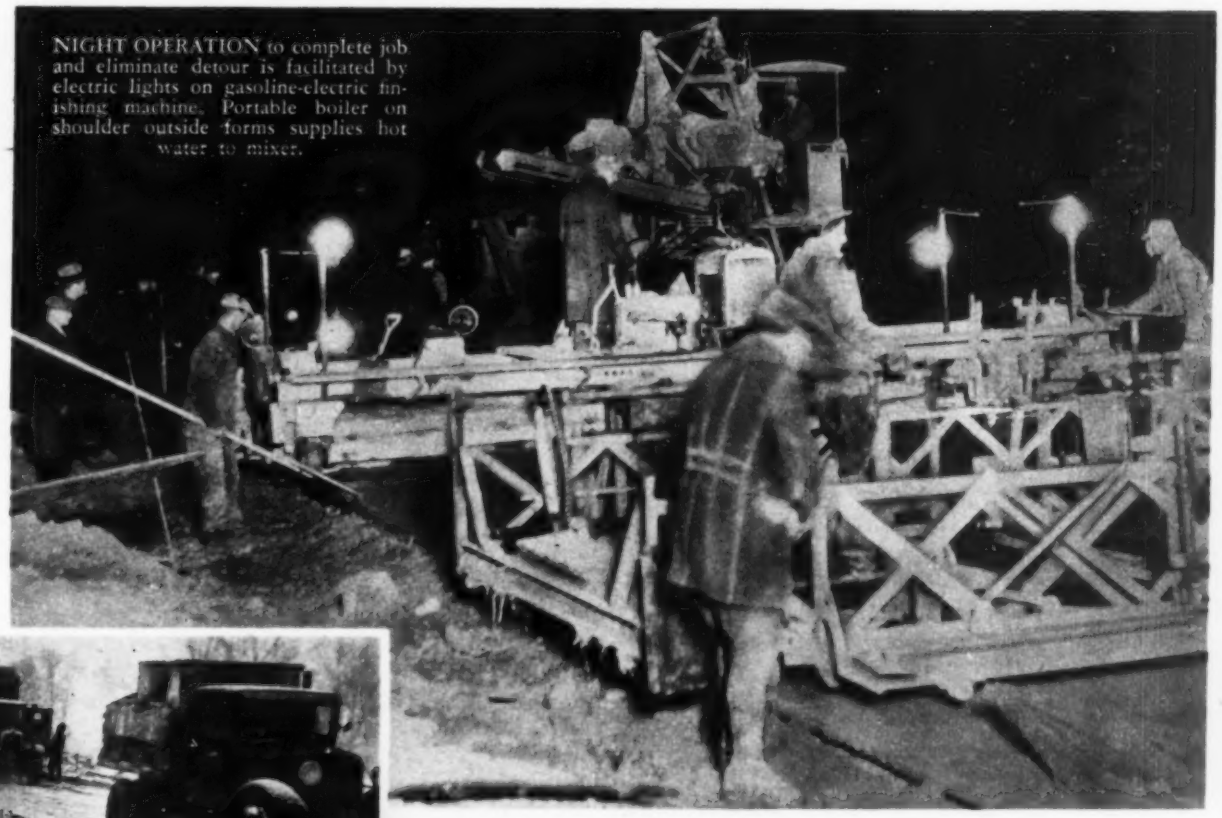
A core machine on the job cut cores at 24, 48 and 72 hr. The average compressive strength of cores at 24 hr. was 1,836 lb. per square inch; at 48 hr., 2,455 lb. per square inch; and at 72 hr., 3,166 lb.

Temperature Records — During the placing of concrete atmospheric temperatures ranged from 52 deg. to 14 deg. above zero, F. During the curing period, the temperature range was from 52 deg. above zero, F., to 7 deg. below zero. A test was made of the temperature at the surface of the slab when the atmospheric temperature was zero. Under 5 in. of straw, the temperature at the surface of the concrete was 35 deg., F.; under 10 in. of straw the temperature was 42 deg.

On one day, when the crew stopped placing concrete, the atmospheric temperature was 14 deg. above zero. By the following morning, the temperature had dropped to 7 deg. below zero. A thermometer placed on the pavement underneath 10 in. of straw on that morning gave a temperature reading of 42 deg. F.

As an incident in the construction of the pavement, the contractors at the end of the job ran the paving mixer continuously from 7 o'clock one morning until 6 o'clock the following morning to complete the work and throw the road open to traffic as soon as possible. A bridge on the public highway being used as a detour had fallen into the stream on the previous day, necessitating an increase in the length of the detour to 8 mi.

Jesse Pochard, resident engineer, Hamilton, Ohio, was in general charge of the Work, with Marc A. Korb as project engineer. The two contractors, Homer R. Crist and Walter Beatty, acted as superintendents.



NIGHT OPERATION to complete job and eliminate detour is facilitated by electric lights on gasoline-electric finishing machine. Portable boiler on shoulder outside forms supplies hot water to mixer.

HEATED AGGREGATES are delivered by two-batch trucks with high-early-strength cement in separate containers. Sand or slag cover on subgrade prevents freezing of soil.

SHEET ASPHALT

Finished With 30-Ft. Remodeled Machine on DAY AND NIGHT JOB

NIGHT WORK with mechanical finisher makes it possible to use street-car rail to carry one end of machine, thus assuring accurate grade on asphalt binder and top.

OPERATING both by day and by night a varied assembly of specially adapted construction equipment widened and paved .68 mi. of Woodward Ave., Detroit, without interrupting service on a high-speed double-track street railway which maintained 1-min. service through the job during morning and evening rush hours. Designed for an expected life far exceeding that of ordinary arterial highways, the new pavement, 90 ft. wide between curbs, includes a 14-15-14-in. concrete track incasement for the street railway and a reinforced-concrete base with a 10-in. center and a 14-in. edge supporting asphaltic vehicular lanes and vitrified-brick parking strips.

Paul Lunstedt Photo

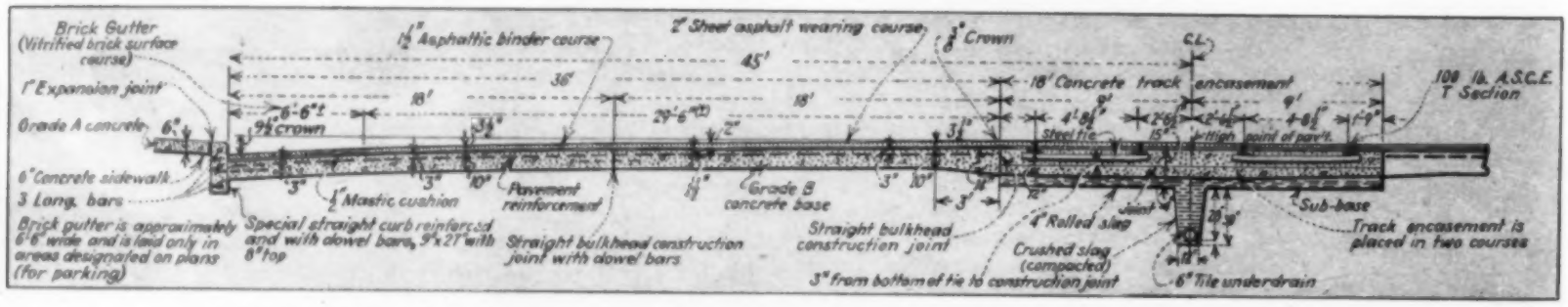
SPECIAL STRIKE-OFF TEMPLET riding on rails screeds surface of sheet asphalt in street-railway track.

WIDENED TO 90 FT. between curbs, Woodward Ave., Detroit, is paved with sheet asphalt on heavy concrete base. Brick parking gutters mark limits within which motorists may leave cars.

The J. A. Mercier Co. and the Detroit Asphalt Paving Co., both of Detroit, acting under separate contracts, built respectively the concrete base and the wearing surface for the Michigan State Highway Department, which had charge of both design and construction of this National Recovery municipal highway project. In conformity with street paving standards of the City of Detroit, the entire concrete base, with the exception of the brick parking gutters, was covered with 1½ in. of hot asphaltic binder and 2 in. of sheet asphalt top.

In the method of laying these asphaltic courses the project presented its most spectacular departure from conventional practice. After the steel rails of the double-track railway had been incased in concrete, they offered a rigid and accurate templet for striking off the binder and top courses. In order to use these rails to carry one end of a finishing machine especially rebuilt to a 30-ft. span for this job, the Detroit Asphalt Paving Co. laid both binder and top courses between 9:30 p.m. and 6:30 a.m., when longer headway between street cars permitted both inbound and outbound cars to be routed over one track for a short distance, with portable crossovers at both ends of the single-track section.

Features of Project — In its full length of 3,592.67 ft., the project embraces a 3,058.41-ft. central portion 90 ft. wide between curbs, with two transition sections, one at each end, of varying width. The new street is widened to 90 ft. between curbs and 120 ft. between property lines from former dimensions of 50 ft. and 90 ft., respectively. Within the limits of the project, intersecting streets abut on Woodward Ave. but do not cross it. In all, there are sixteen junctions of this kind, with



PARTIAL SECTION of Woodward Ave. pavement. Heavy concrete track incasement on rolled slag subgrade, reinforced-concrete pavement base, and sheet-asphalt wearing surface with brick parking strips are features of enduring street construction.

Paul Lunstedt Photo

ON JOB NIGHT AND DAY. *(Left to right)* Julius Porath, vice-president, and A. P. Hanan, general manager, Detroit Asphalt Paving Co.; C. L. Shattuck, assistant construction engineer, and V. B. Steinbaugh, road engineer, Michigan State Highway Department.

side streets intersecting one curb of Woodward.

As a part of the project, a railroad bridge across Woodward Ave. carrying two tracks of the Grand Trunk Western and three tracks of the New York Central was increased in clear span from 54 ft. to 95½ ft. The bridge work was performed by the D. W. Thurston Co., of Detroit, under a separate contract.

Two Street Contracts — An accompanying drawing reproduces a partial cross-section of the new Woodward Ave. pavement. Contract No. 1, of the J. A. Mercier Co., called for 30,834.6 sq.yd. of concrete base (10 in. center, 14-in. edge) reinforced with 5.4 lb. of welded wire fabric per square yard, 2,972.4 cu.yd. of Grade A concrete (not reinforced) for track incasement, 89,778 sq.ft. of 6-in. concrete sidewalk, 1,179 sq.ft. of 4-in. concrete sidewalk, 6,941 lin.ft. of 7-in. street curb (total depth, 27 in.) and 763 lin.ft. of special driveway returns.

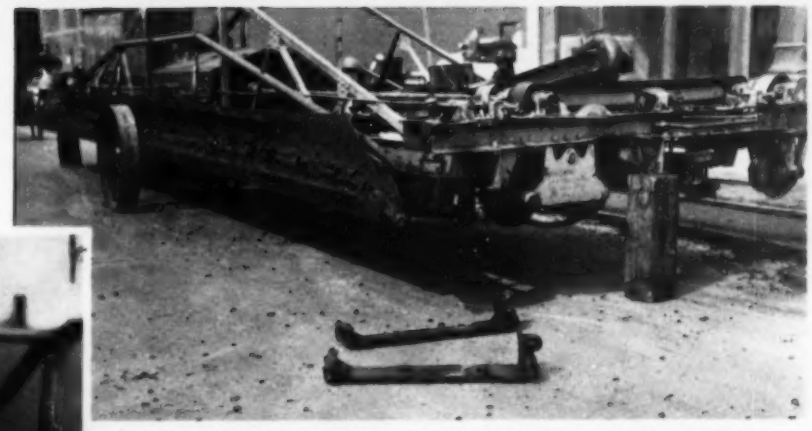
Contract No. 2, of the Detroit Asphalt Paving Co., involved 34,264.9 sq.yd. of 1½-in. binder course and 2-in. sheet-asphalt top. Parking lanes adjacent to the curbs called for 3,916.9 sq.yd. of vitrified brick laid on a ½-in. sand-asphalt mastic cushion.

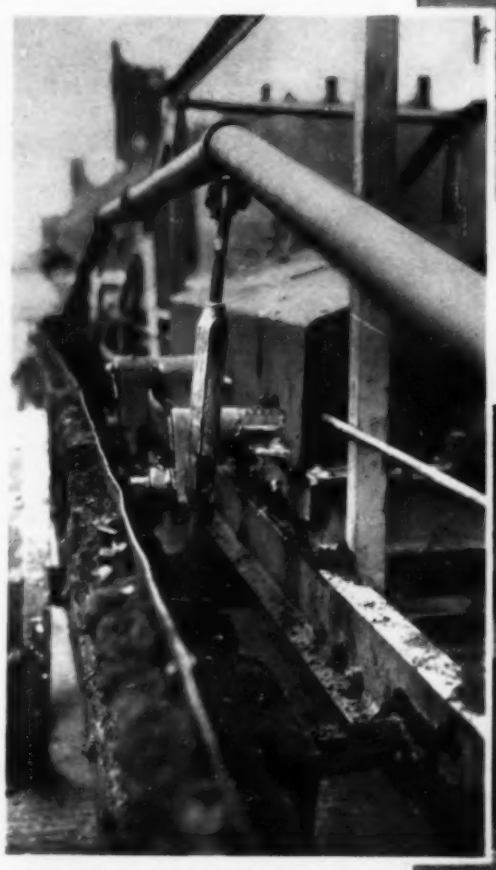
Progress—Throughout the course of the paving work the contractors maintained satisfactory rates of progress. The two street contracts were awarded Feb. 8, 1934. About ten companies, including the public utility corporations, had to move ducts buried in the old street. Temporary tracks for the street railway were laid down the east side of the work and were depressed 4 ft. at the site of the bridge to clear the 8-ft. girders of the new 95½-ft. span, which was to be erected before street railway service could be restored to the permanent tracks. On May 24, a paving breaker (consisting of a power shovel which dropped a heavy weight in guides at the end of its boom) began to demolish the old pavement.

By June 25, the Mercier organization was able to start placing concrete track base, the first of the concreting operations. The base was laid 5-6-5 in. thick and 18 ft. wide, with a level top. After placing the track to accurate line and grade on granite blocks supported by this base and incasing the steel ties and rails in concrete, the contractor laid the adjacent pavement base in 18-ft. strips. In spite of manholes, street intersections and other obstacles, a single 27-E paver employed on this work averaged 500 to 600 lin.ft. of 10-in. base in 10 hr. On one day, the concrete crew laid 900 ft. of 10-in. base 18-ft. wide. The batchmeter was set for a 60-sec. mixing period.

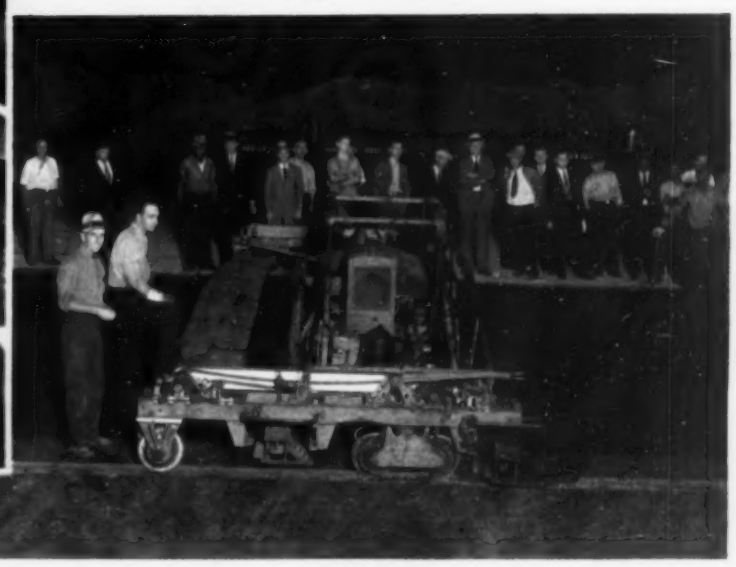
Sufficient base was completed by Aug. 24 to enable the Detroit Asphalt Paving Co. to start binder and top course. The asphalt crew laid about 200 tons per night (equal to 1,140 sq.yd. of 1½-in. binder and 2-in. top), and an additional crew often was engaged in performing supplementary asphalt paving during the day. Brick parking

30-FT. FINISHING MACHINE, rebuilt to greater span from 20-ft. size, strikes off binder course for compaction by battery of three rollers. At right end, machine rides on street-car rail; at left end, wheels travel temporary form spiked to 4-ft. shoulder of binder material placed in advance. Powerful overhead lights illuminate construction area.





ANGLE PLATE bolted to screed of finishing machine *(above)* strikes off binder course below grade of finished surface. Compression dollies (lying on concrete base) have pusher wheels which bear against forward traction wheels of finisher. Forward rollers of dollies are adjustable to give required excess depth under screed. ENLARGED FINISHER *(below)* has additional third traction wheel at each end. Screed rides on compression dolly, which is channel-shaped to fit form.

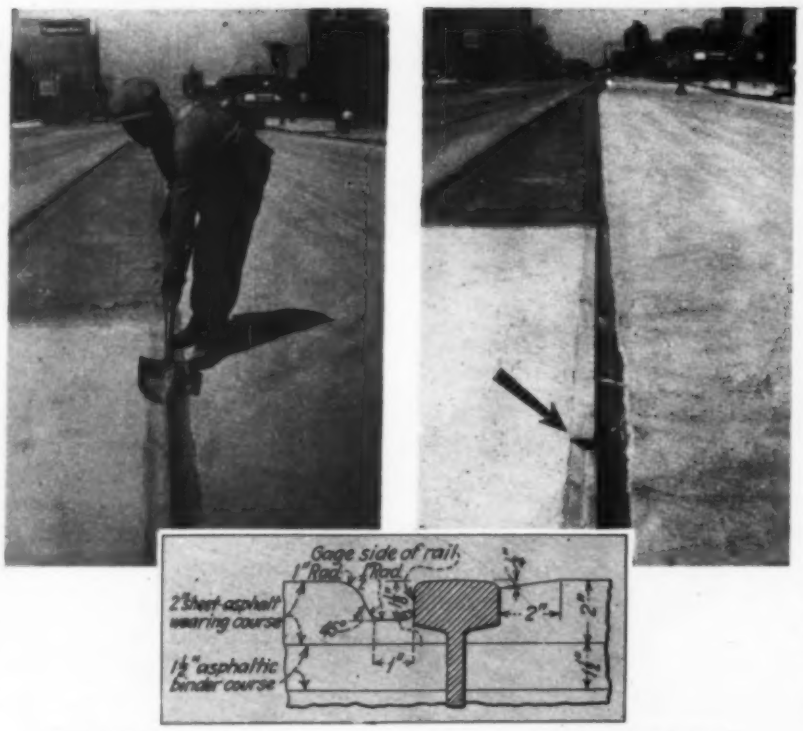


TURNBUCKLE HANGERS from tubular truss at third-points of screed facilitate crown adjustment while machine is in operation.

strips were laid by a day shift. The entire paving work was completed Sept. 28.

Concrete Plant—A batching plant consisting of two separate overhead bins and a combination storage and loading shed for sacked cement was erected by the J. A. Mercier Co. on an unoccupied lot on the west side of Woodward Ave. south of the railroad bridge. Two grades of concrete were required, one for the pavement base and the other for track incasement, with the richer mixture specified for the trackwork. Both mixtures used two sizes of crushed slag as coarse aggregate.

Dry batches were delivered to the charging skip of a 1-yd. paving mixer which produced concrete for all purposes — track incasement, pavement base, sidewalk and curb. The pavement base concrete was struck off and finished in 18-ft. lanes by a conventional gasoline-powered finishing machine traveling on steel rail forms. To provide a stronger bond with the asphaltic binder course, the surface of the concrete base was corrugated transversely with grooves ⅜ in. deep on 1½-in. centers. These grooves were formed by ⅜-in. round wires clamped on a 30-in.



SPECIALLY SHAPED SHOVEL *(above, left)* **trims excess material from grooves along rail after they have been formed by templet. WOODEN MOLD STRIP** *(above, right)* **fills groove on gage side of rail while rollers travel back and forth across rail, compacting sheet asphalt. DETAIL** *(in inset)* **of groove on gage side of rail and sloped shoulder on other side designed to avert disintegration of sheet asphalt under traffic.**

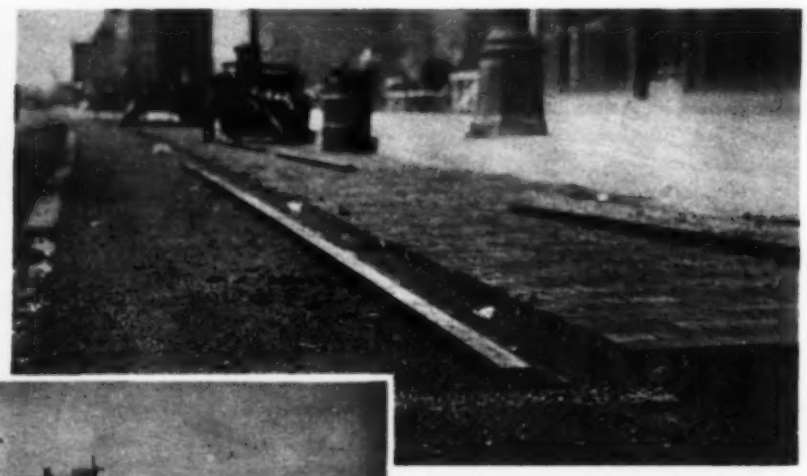
per minute and an equal rate of screed oscillation (65 to 70 strokes per minute) were required for a plane surface free from waves and checks.

To propel the heavier machine at a uniform speed, a third traction wheel was added at each end. Compression plates, or screed dollies, channel-shaped to fit the rails, were equipped: (1) with pusher wheels to bear against the forward traction wheels of the finisher, and (2) with adjustable rollers, riding on the forms, which could be regulated to control the excess depth of asphaltic materials allowed for compaction under the power rollers.

A tubular truss supported the 30-ft. screed near its third points by two turnbuckle hangers. Adjustments in the crown of the screed could be made readily by twisting the turnbuckles without stopping the motion of the screed. A steel angle bolted to the bottom of the screed, as shown by an accompanying photograph, struck off the binder course at the desired depth below top of rail.

Three steam rollers of 10- to 12-ton weight and a smaller, more flexible gasoline-powered roller compacted the binder and sheet asphalt courses behind the finishing machine, rolling the pavement both longitudinally and transversely. The pavement was held rigidly to a specification limiting surface irregularities to 3/16 in. in 10 ft. Inspectors checked the top carefully with 10-ft. straight-edges. No paving man could watch the 30-ft. screed and four power rollers laying asphalt top to this specification at night on a 90-ft. street brightly lighted by strings of high-power lamps without being impressed by the efficiency, experience and energy that made the operation possible.

SPECIAL FLOAT, with ⅜-in. wires clamped to it, cuts transverse grooves in surface of concrete base.



STEEL RAIL with wooden core, spiked to shoulder of binder course, carries one end of finishing machine. Brick parking gutter has been placed adjacent to curb.

STEEL TIES AND RAILS, set to accurate line and grade on granite blocks resting on lower course of concrete, are ready for final course of track incasement.

float, illustrated by one of the photographs. Asphalt emulsion was sprayed on the concrete to seal the surface during the curing period. This asphalt application served as a prime coat for the binder.

Asphalt Paving—A 20-ft. Ord (Blaw-Knox) finishing machine was rebuilt to 30-ft. width by the Detroit Asphalt Paving Co. to strike off and screed prior to rolling both the binder course and the top course in the space between the outside rail of the street car track and the brick gutter. Originally it had been intended that this enlarged machine should run at both ends on temporary rails laid either on concrete or on asphaltic courses placed by hand. To take advantage of the absolutely true grade offered by the concrete-incased track rail, the plan was modified to permit one end of the finisher to travel on this rail. At the other end, a temporary rail was laid on a 4-ft. strip of hand-placed binder. Night operation was necessary to avoid undue interference with street railway service. The Detroit Street Railways readily accepted this arrangement and agreed to furnish adequate lighting for the work.

In rebuilding the finisher, the paving company's master mechanic introduced specially cut reducing gears so arranged that a suitable selection of forward speeds and screed strokes per minute could be obtained as required for the two asphaltic courses. These working speeds were determined by actual experience on the pavement. For the 1½-in. binder course, a forward speed of 5½ to 6 ft. per minute and 65 to 70 screed strokes per minute proved effective. On 2-in. sheet asphalt top, a much slower forward speed of 31 in. per minute and 75 to 80 strokes per minute were required.

Asphalt Mixtures — For the binder course the mixture consisted (by weight) of 76 per cent hard blue limestone (1½- to ¼-in gradation), 19.2 per cent pit sand and 4.8 per cent asphaltic cement (Mexican asphalt, average 56 penetration). Two mixtures were used on the top, one employing

limestone dust as filler and the other incorporating silica dust. In both mixtures the asphaltic cement was a blend of equal parts of Mexican oil asphalt and Trinidad native lake asphalt. This blend gave a bitumen content of 85 to 86 per cent and an average penetration of 50. The sand grading (average of all materials accepted) showed 35 per cent passing an 80-mesh and retained on a 200-mesh screen. Both mixtures were designed to obtain 2,000-lb. stability (Hubbard-Field), with 2 per cent to 4 per cent voids in the compressed mixture. Daily tests showed the mixtures to vary from 1,800- to 2,400-lb. stability and to contain 2 to 4.5 per cent voids.

Weight percentages of the two top mixtures are given by the accompanying table. The difference in percentages is due to the difference in volume weight of the limestone and silica dust. Prior tests had established the void-reducing capacity of the two fillers.

7 mi. from the Woodward Ave. contract. The asphaltic cement for the top mixture was blended from separate tank cars at this plant. Trucks hauled 12,600-lb. loads (seven 1,800-lb. batches) of binder and 12,000-lb. loads (six 2,000-lb. batches) of top from the plant to the job. Binder mixture was delivered at a temperature between 225 and 325 deg.F. and top mixture at a temperature between 250 and 350 deg. F. The materials were dumped on the street and were turned over with forks before being struck off by the finisher.

Night Lighting—Work was in progress on only one side of the street at a time. The street railway organization lighted the side under construction for an ample distance (of perhaps 1,500 ft.) by three overhead lines of 500-watt lamps. These lamps were installed in pairs spaced 50 ft. apart. In addition, the paving crew was supplied with a portable set of six 600-watt lamps (equipped with reflectors) which tapped into the unused trolley wire of the railway. The new street-lighting system for Woodward Ave., already in service, added a share of illumination.

Brick Gutters — Vitrified paving brick in the 6½-ft. parking strips adjacent to the curbs were laid by a day shift on a ½-in. compacted depth of mastic cushion composed of 92 to 95 per cent (by volume) clean dry sand and 5 to 8 per cent asphalt cutback. The joint filler for the brick pavement was a pure asphalt applied at about 350 deg.F. Before applying the filler , the crew sprayed the surface of the bricks with a calcium chloride and starch solution which prevented bonding of the asphalt to the top of the pavement and permitted easy removal of the excess asphalt. The solution was made up of three ingredients in the following proportions: calcium chloride, 100 lb.; water, 25 gal.; and starch, 3 lb. In hot weather, the proportion of starch was increased.

Brick parking lanes in asphalt street construction have two major advantages. They eliminate softening of the asphaltic surface caused by oil drippings from parked cars, and they mark definitely and decisively the only areas in which motorists may legally leave their vehicles.

Other Daylight Work—In addition to the brick gutters, the contractor often employed day shifts to lay the 4-ft. binder strip next to the brick gutter (needed to support the temporary rail under one end of the finishing machine) and to pave street intersections. On at least one Sunday, when railway traffic was light, a day shift was employed to pave between the rails of one track.

Special Paving Details—A V-shaped cut was made in the existing asphalt surface of all intersecting side streets. By putting the joint on diagonal lines, where the wheels of a passing vehicle would not strike it simultaneously, the state highway engineers hoped to avoid any sensation of bumpiness which a rider may experience at a right-angle transverse joint, no matter how carefully it is straight-edged and rolled. A similar diagonal joint was made in the sheet-asphalt wearing surface on Woodward Ave. between successive runs of the paving operations.

Administration — Murray D. Van Waggoner is state highway commissioner of Michigan and Harry C. Coons is deputy commissioner and chief engineer. The Woodward Ave. paving project was designed and executed under the general direction of V. B. Steinbaugh, road engineer, Lansing, with H. E. Edison, project engineer, in charge at the job. C. L. Shattuck, assistant construction engineer of the state highway department, supervised the asphalt work. A. P. Hanan, general manager, directed operations for the Detroit Asphalt Paving Company. For the J. A. Mercier Co., Frank Knight was in general charge, and Roy Kincaid was superintendent.

H. E. EDISON *(below)*, project engineer for State Highway Department, directs operations on job.

Photos by Paul Lunstedt

BRICK PARKING STRIP *(left)* 6½ ft. wide is laid and rolled on sand-mastic cushion alongside curb.

EXCESS JOINT FILLER *(right)* readily peels off surface of brick parking gutter, which was sprayed with calcium chloride and starch solution before asphalt filler was applied.

ASPHALT FILLER *(left)* for joints of brick gutter is poured after surface of bricks has been sprayed with solution.

EMULSIFIED ASPHALT *(right)* sprayed on surface of concrete base serves both as curing agent for concrete and as primer for asphaltic binder course.

SHEET ASPHALT MIXTURES

	Weight Percentages	
Material	*Mix No.* 1	*Mix No.* 2
Sand	74.0	75.8
Limestone dust	14.5	
Silica dust		12.5
Asphaltic cement (86 per cent bitumen)	11.7	11.5

Daily analyses of the top mixtures (by extraction) averaged 9.8 per cent bitumen in mixture No. 1 and 10.2 per cent in mixture No. 2. The same tests revealed average specific gravities of 2.245 for No. 1 and 2.180 for No. 2.

Asphaltic mixtures for binder and top were produced at a permanent asphalt plant situated on a railroad siding

Out of the Mo

COMES THIS LETTER OF APPROVAL ON THE "AC" OIL TRACTOR . . .

CHARLES SKEETERS — EVERETT SKEETERS

SKEETERS BROTHERS
TALENT, OREGON

November 13, 1934

Mr. A. E. Mills,
Allis-Chalmers Mfg. Company,
Portland, Oregon.

Dear Sir:

In the spring of this year we purchased an Allis-Chalmers tractor from the Brewer Tractor and Equipment Company of Medford. We wish to report that outside of a few breakages and minor repairs, we have found that this tractor does the work that we expected it to do.

This tractor was used to log pine and fir in the Wagner Creek district. Our method is ground skidding to a landing, where we use a loader to load our trucks. We believe that this tractor has anything beat for logging in the woods that we have ever seen. During the season it worked on some of the worst ground we believe that has ever been tractor logged. We were unable to use another tractor on some of the ground that we used this "LO" on.

The average fuel cost was around $1.96 per day, fuel costing 7-1/2 cents delivered to the job. We experienced no difficulty in starting or with crankcase dilution in the motor. The average amount of logs put to the landing for the season was 40,000. On many landings we worked from nothing to one-half a mile.

This is one of the greatest hill-climbing tractors we have ever seen and we would especially recommend it for rough and hilly logging.

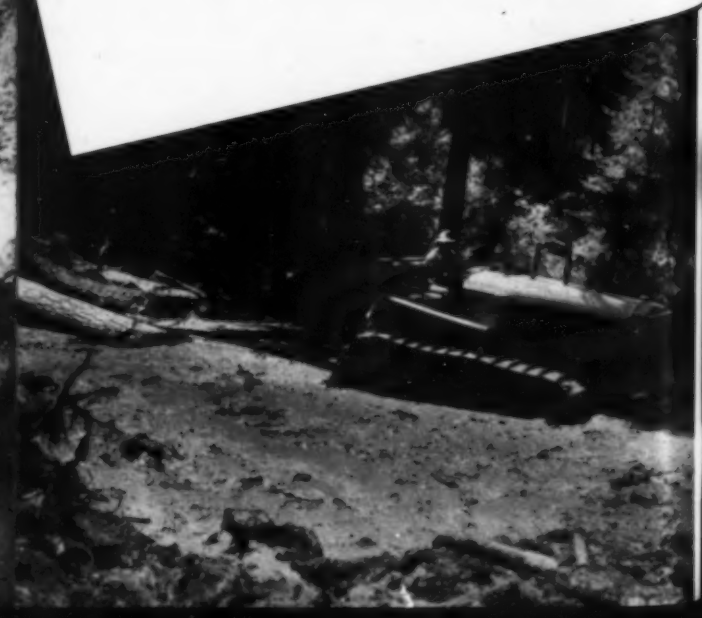
In the morning it took us about five minutes from the time we started the motor until we would be logging. We believe this is a very good record in that one has sen idle until the tractor gets into operation.

We would be pleased to demonstrate and recommend this tractor to any logger or contractor that would like a word from us.

Sincerely yours,

Charles L. Skeeters

SKEETERS BROTHERS



70% SLOPES

Up and down 60 and 70 per cent slopes—this work demands an engine that is "always there". A second's delay may mean the operator's life.

GROUND SKIDDING

On overloads that pull a tractor down to the last pound . . . the A-C Oil engine's ability to hang on gets those big loads over the hump.

RADIATOR DEEP

If the "L-O" weighed any more it would be out of sight in this mud hole. Why carry dead weight up hill or in mud?

Thwest

SKID ROADS

Built for a week's or a month's use, skid roads must be constructed cheaply — and the "L-O" gives lowest final cost. Plenty of power here!

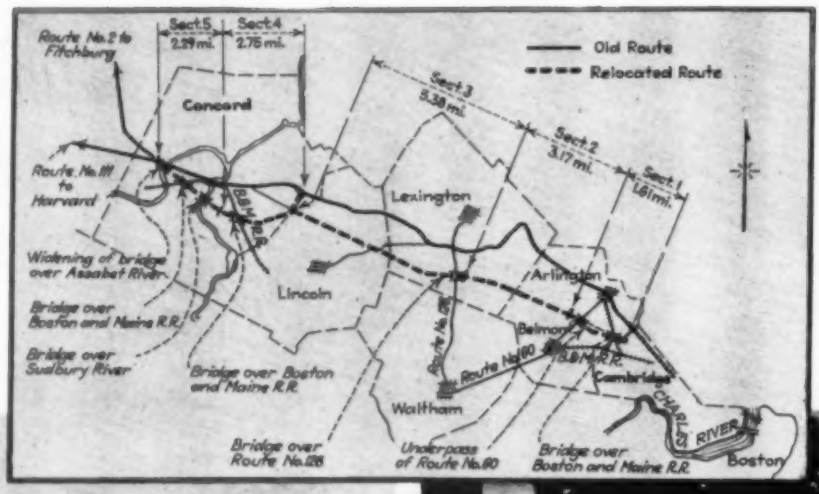
Logging service is without question the toughest of all tractor jobs. It takes that extra something which A-C tractors have to stand the punishment of working on rocky slopes, over trees, in continual dust, on big overloads. A-C's will give dependable performance on YOUR job, too.

ALLIS-CHALMERS
TRACTOR DIVISION—MILWAUKEE, U. S. A.

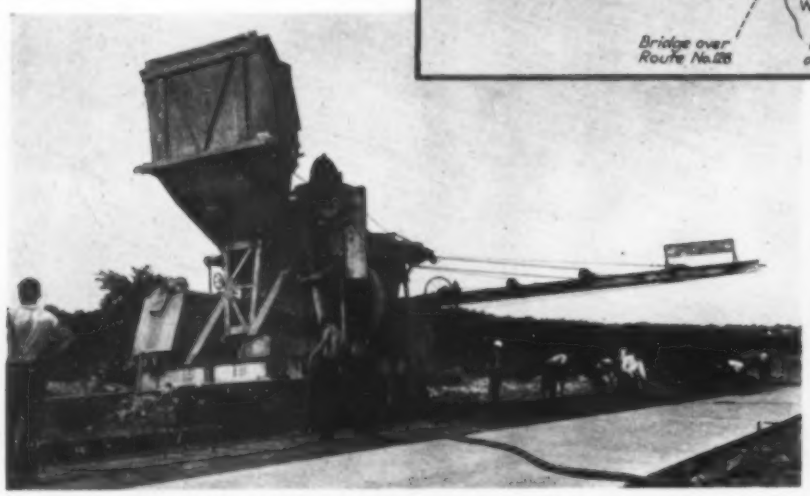
MAIN ROUTE RELOCATION

Involves Heavy Grading and Multiple-Lane Paving on 15-Mile Cambridge-Concord Bypass in Massachusetts

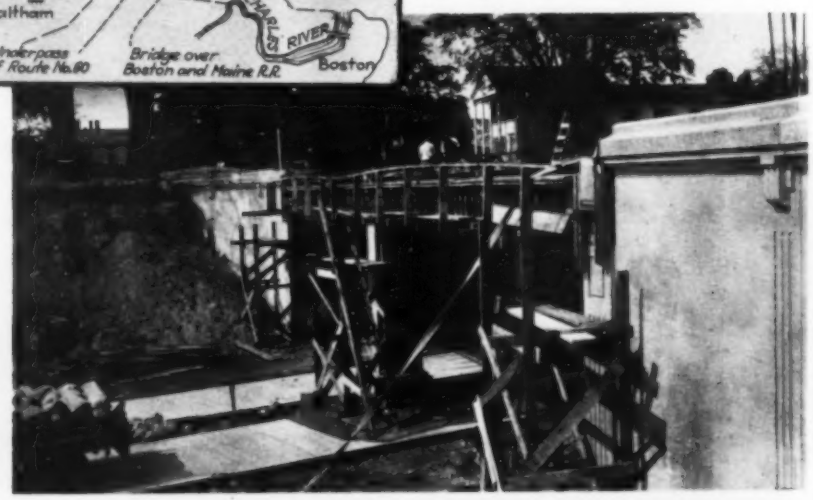
EXCEPTIONALLY heavy grading, involving the movement of about 22 cu.yd. of material per linear foot of road, and paved widths of from 40 to 60 ft., mark the construction of the new trunk-line highway 15.2 mi. in length which the Massachusetts Department of Public Works is building between Cambridge and Concord, at a cost of $2,465,500 (including seven bridges) as a relocation of part of Route No. 2, which traverses northern Massachusetts in a general east-west direction and constitutes a main traffic artery between Boston and Albany, N. Y. Graded to a width of 100 ft., the new highway, with multiple traffic lanes paved with concrete and bituminous macadam (on fills), is not essentially a job of reconstructing an existing road. Instead, it represents an entirely new and improved parallel alignment, with moderate grades and comparatively few curves, located south of existing Route No. 2 so as to avoid the business centers of the towns of Cambridge, Belmont, Arlington, Lexington, Lincoln and Concord.



RELOCATED ROUTE *(left)* of Cambridge-Concord highway, showing straightened alignment and bypass around town of Concord.



ON SIX-LANE SECTION of pavement at easterly end concreting is handled by paving mixer.



UNINTERRUPTED TRAFFIC flow on new highway is insured by building bridges to eliminate crossings at grade.

To insure an uninterrupted flow of fast moving traffic on the new route, highway and railroad grade crossings have been eliminated at five points by bridges, in addition to two other bridges at river crossings. At its westerly end the highway swings to the south so as to bypass completely the town of Concord and allow traffic from Boston to proceed without delay toward Fitchburg and points west. In its broad purpose to meet the demands of modern traffic and in the general character of its design the Cambridge-Concord highway is comparable with another of Massachusetts' outstanding highway development projects, the Boston-Worcester turnpike, described in *Construction Methods* for January, 1933.

CARRYALL SCRAPER, with a capacity of 12 cu.yd., is operated by 75-hp. diesel tractor on heavy grading at westerly end of job.

Quantities—On the 15.2 mi. of the relocated Cambridge-Concord highway the amount of material moved totals 1,754,550 cu.yd., consisting of the following classifications:

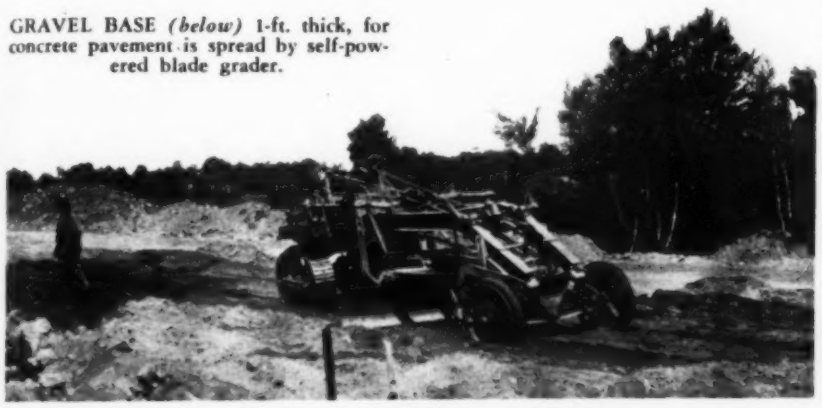
Earth excavation,	671,100	cu.yd.
Ordinary borrow,	784,400	" "
Ledge excavation,	53,200	" "
Gravel borrow,	245,850	" "
Total material to be moved	1,754,550	" "

In addition, the paved surface requires a total of 79,050 cu.yd. of concrete. Of the total estimated cost of $2,465,500 for the project, $2,181,000 is for pavement, including grading, and $284,500 for seven bridges.

The project, as indicated on the accompanying sketch, is divided into five sections; contracts for four of them (Nos. 1, 3, 4 and 5), comprising 12.03 mi., (including six bridges) were awarded to B. Perini & Sons, Inc., of Framingham, Mass., while Section 2, covering 3.17 mi., was bid in by the George A. Fuller Co., of Boston, a firm identified for many years principally with the construction of large buildings. One separate contract for a bridge crossing the route in Lexington is held by Warren Bros. Co., of Cambridge.

WHERE LEDGE ROCK is encountered on route deep blast holes are put down by wagon drills while shallower holes are sunk with jackhammers.

GRAVEL BASE *(below)* 1-ft. thick, for concrete pavement is spread by self-powered blade grader.



E. R. BOUCHER *(below)*, senior construction engineer, in charge for Massachusetts Department of Public Works.

Route — Starting at the Cambridge, or easterly, end of the route, Section 1 leaves existing Route No. 2 at Alewife Brook Parkway, and extends northwest for 8,513 ft. through Cambridge, Belmont and Arlington, with one 3-span concrete and steel bridge over the tracks of the Boston & Maine R. R. and another 2-span steel deck concrete structure carrying existing Route No. 60 over the new highway in Arlington. On this section of the project, forming the entry to the new highway, the pavement is wider than elsewhere on the line, consisting of six 10-ft. traffic lanes grouped into two 30-ft. paved roadways separated by a 20-ft. central grass plot. About half of the length of this section is paved with standard reinforced concrete 8 in. thick and the other half, mainly on fill, with bituminous macadam. Toward the west end of this section, just before reaching the underpass below Route No. 60 in Arlington, there is a transition in which the 60-ft. paved width is reduced to 40 ft., and the separating grass plot is eliminated.

Section 2, in Arlington, Belmont and Lexington, covers 16,754 ft. of 40-ft. wide "sheet" concrete, consisting of a 7-in. base course and a 2-in. top course, separated by a jute fabric membrane in order to allow the 2-in. upper course to be split off, removed and replaced whenever the pavement becomes worn sufficiently to require resurfacing.

WAGON MOUNTING carries pneumatic drill for putting down deep blast holes in ledge rock.

Section 3, in Lexington and Lincoln, comprises 28,390 ft. of 40-ft. wide "sheet" concrete, similar to that of Section 2, and an underpass involving a 60-ft. span rigid-frame concrete arch bridge over Route No. 128 in Lexington.

Section 4, traversing the township of Concord, includes a 3,000-ft. length of 30-ft. wide bituminous macadam forming a cross-connection with existing Route No. 2 a couple of miles east of Concord and 11,500 lin.ft. of main trunk-line concrete paving 40 ft. wide and 8 in. thick. A 5-span steel and concrete bridge over the tracks of the Boston & Maine Railroad is included in this section.

Section 5, the final length of the highway skirting around Concord to the South and making connection with Route 2 at a point west of the town, includes 12,100 lin.ft. of 8-in., 40-ft. wide concrete and three bridges, one over the B. & M. R.R. tracks, one across the Sudbury River and the third, a widening job, over the Assabet River.

The completion of the relocated highway, therefore, will substitute for the existing crooked and comparatively narrow Route No. 2, carrying only two lines of traffic, a broad, straight 4-lane (6 lanes at the Cambridge end) east-west thoroughfare of modern construction bypassing the congested centers of the towns through which it passes and provided with bridges or underpasses at other key points to minimize interference by cross traffic.

Pavement Design — For all paving of high type, whether it be of concrete or bituminous materials, Massachusetts standards require a rolled gravel subbase 12 in. thick for purposes of drainage and load distribution.

A 40-ft. width of paved roadway constitutes the main portion of the Cambridge - Concord highway. The state's standard calls for a one-course reinforced concrete slab with a uniform thickness of 8 in., built in lanes 10 ft. wide. At each side of the paved surface are 5-ft. bituminous macadam shoulders consisting of a 4½-in. thickness of broken stone penetrated with 2¾ gal. of asphalt per square yard.

Joints—Transverse expansion joints of the slip dowel type, with premolded strips of joint filler installed with a steel bulkhead and cap, are spaced 56

BULLDOZERS, mounted on tractors, aid in distributing earth fill.

HEAVY EARTH FILL forms approaches to bridge over railway tracks in Cambridge.

ft. 2 in. apart. For each 10-ft. lane there are seven ¾-in. plain round steel bar dowels each 2 ft. long, solidly embedded in the concrete slab on one side of the joint and coated with bituminous paint on the other half of their length to break their bond with the concrete. In order to provide for free expansion of the concrete and to prevent the buckling of the dowels their painted ends are incased in paper tubes or metal caps with closed ends extending about 1 in. beyond the ends of the dowels, to provide a clearance space for the steel bars.

The main steel reinforcement for the slab consists of longitudinal and transverse bars supported at a height of 2 in. above the subgrade by a spring clip chair, left in place as the concrete is poured. Extra strength at the corners of each slab is provided by the installation of 6-ft. corner bars bent at right angles.

Longitudinal joints are doweled with deformed steel bars 4 ft. long, placed 5 ft. on centers, and the vertical faces of the slabs receive a coat of bituminous paint.

Along the center line of the 40-ft. paved width a black traffic guide line is built integral with the white paved surface. It consists of a strip of bituminous concrete placed in a channel 12 in. wide and 2 in. deep formed in the surface of the concrete.

Originally 6-in. planks were laid in each concrete slab adjacent to the centre line to form the recess for the bituminous concrete marker strip. Results were not entirely satisfactory with that method so, for the greater portion of the length of the highway, the concrete pavement was moved out 6 in. from the centre line on each side. The resulting 1-ft. space was later filled with concrete for a base and the 2 in. of bituminous concrete marker laid on this base. This method gives slab edges straight and true, whereas planks set in the surface

CONCRETE BRIDGE is built to carry new highway over tracks of Boston & Maine Railroad in Concord.

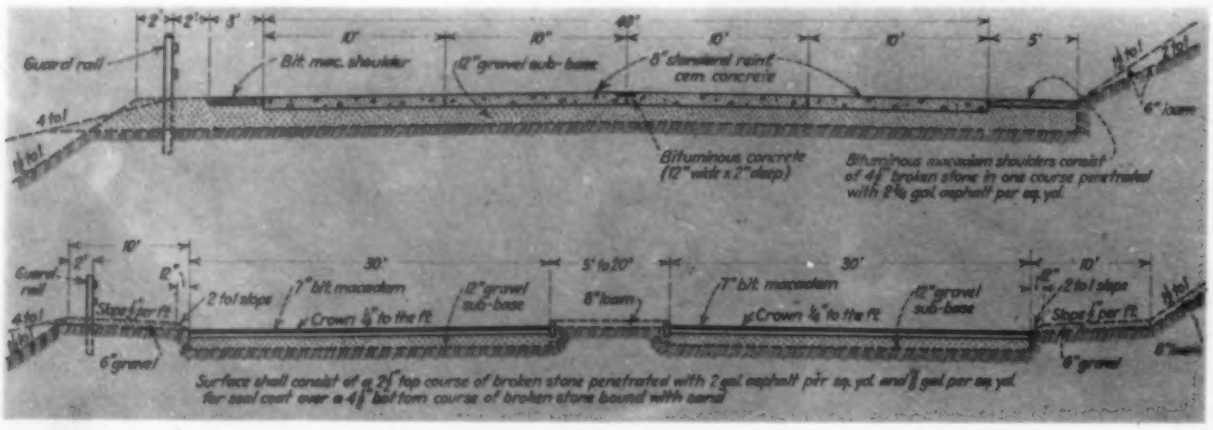
were moved about by the screeding machine, resulting in wavy, irregular edges of the slabs and the bituminous concrete strip.

Sheet Concrete — The "sheet" concrete design provides for a 9-in. thickness of concrete, lightly reinforced, and built in two courses with a sheet of coarse-mesh (¼—⅜-in. openings) jute fabric interposed between them to form a cleavage plane between a lean (1:2½ :5) mix 7-in. base course and a richer (1:1½:2½) mix 2-in. top or wearing surface. With this type of construction the top 2 in. of concrete may be removed and replaced when resurfacing is needed.

Concrete Mix—Specifications governing the concrete mix permit the use of either a paver, operating on the subgrade, or truck mixers. Both types are being employed on this project. For the paver type of equipment a minimum mixing time of 1¼ min. is required. With truck mixers, however, the mixing time must be not less than 5 min., and the batch must be discharged on to the subgrade by a belt conveyor or other approved device, but not by chutes.

SEPARATION OF GRADES at intersection of new highway with existing route, showing gradual transition in width of concrete pavement from 60 to 40 ft.

On the Perini contract sections an improved mechanical spreader is employed to distribute upon the subgrade concrete from the 5-yd. truck mixers. Its new feature is a steel chute, instead of the pair of short belt conveyors formerly used, for delivering the mixed batches to one long screw conveyor (replacing two shorter screw conveyors) for spreading the concrete between the forms. This change, Superintendent A. Lattanzi reports, in addition to reducing the weight of the machine by several hundred pounds, increases the dependability of the outfit by eliminating


Guard rail
Bit. mac. shoulder
12" gravel sub-base
8" standard reinf. cem. concrete
4 to 1
Bituminous concrete (12" wide x 2" deep)
Bituminous macadam shoulders consist of 4" broken stone in one course penetrated with 2½ gal. asphalt per sq. yd.
6" loam
7" bit. macadam
Crown ½" to the ft.
5' to 20'
30'
2 to 1 slope
Slope ½" per ft.
6" gravel
Surface shall consist of a 2½" top course of broken stone penetrated with 2 gal. asphalt per sq. yd. and ½ gal. per sq. yd. for seal coat over a 4½" bottom course of broken stone bound with sand

TYPICAL CROSS SECTIONS *(left)* of concrete and bituminous macadam pavement.

lost time due to the breaking of belts or the necessity of replacing worn belts every month.

With regard to the cement factor for the mix, the state requires at least 1.6 bbl. of cement per cubic yard of concrete for standard one-course construction. For sheet concrete the cement factor is 1.10 for the bottom course and 1.90 for the top course. The ratio of water to cement must not exceed 5½ gal. per bag.

Bituminous Macadam — On certain portions of the Cambridge end of the new route where fills occur (and for the 3,000-ft. cross connection to existing Route 2 in Concord) bituminous macadam construction on a 12-in. gravel sub-base is specified. This type of pavement, for which Massachusetts has built up an enviable reputation, calls for a 7-in. rolled thickness of broken stone, consisting of a 2½-in. top course penetrated with 2 gal. of hot asphalt per square yard, supplemented by screenings and a seal coat of ⅜ gal. per square yard.

The wearing surface is supported by a 4½-in. thick bottom course of broken stone bound with sand or stone dust. The base course stone must have a percentage of wear not exceeding 4 and consists either entirely of No. 1 stone (passing 2¾-in. and retained on 1¼-in. ring) or of a mixture of No. 1 and not more than 40 per cent of No. 2 (passing 1¼-in. and retained on ¾-in. ring) stone. This course is thoroughly bound with clean sand or stone dust. Before the base course is spread shoulders are built to hold the stone in place. Rolling is done with a 12-ton, three-wheeled roller.

For the 2½-in. surface course a harder stone, with a percentage of wear of not more than 3, is specified. It consists entirely of No. 1 stone, compacted by a 12-ton roller, and covered with pea stone to blot the application of bituminous material during rolling. The surface of the bituminous macadam pavement is built with a crown of ¼ in. per foot, and must not vary by more than ⅜ in. from a true plane, as tested by a 10-ft. straight-edge. The resulting pavement, with its top course of fairly coarse stone, presents a rough-textured, though smooth-riding, surface and for motor traffic is possessed of excellent anti-skid qualities.

Grading—The large amount of grading required by the new alignment of this project was handled in the main by two types of equipment, (1) power shovels loading into motor trucks and (2) 12-yd. carryall scrapers operated by 75-hp. diesel tractors. A considerable amount of ledge rock required the drilling of deep blast holes by well drills on two-wheel wagon mountings, as illustrated. On the fills material delivered by the trucks was moved to place by tractor-operated bulldozers.

While most of the grading operations followed routine practice and employed conventional equipment, a novelty—at least on road building in the East—was introduced on the Concord end of the job, where no ledge rock or large boulders were encountered. Here Louis Perini introduced two 12-yd. Le Tourneau carryall scrapers. This machine is a California product which has been used extensively on large earth-moving operations in the Far West but which, until last year, had seen service on the Atlantic seaboard only on this job and on one of the roads built for the Connecticut Highway Department.

Hauled by a 75-hp. diesel tractor which, through a power control unit, also regulates digging and dumping operations from the driver's seat, the scraper consists of a welded steel bowl, with a capacity of 12 cu.yd., carried on six wheels fitted with large pneumatic tires carrying air at 30-lb. pressure. The bowl, open at the front end, is pivoted on the rear axle and supported at the front axle by an inclined post and steel cables, so that its cutting edge may be tilted downward into digging position and raised into carrying position clear of the ground when a full load has been obtained. Dumping is accomplished by a steel plate or tail-gate which is pulled forward by cables from the power control unit through the body of the bowl, pushing the load of earth out in front of it in a thin layer of uniform depth. The tractors hauling these carryall scrapers are geared to operate at six speeds, ranging from about 2 to 5 mi. per hour. In favorable material the loading time is from 1 to 1¼ min. In spite of its bulky appearance the tractor-hauled rig can make a U-turn within a radius of only 22 ft.

Bridges—Of the seven bridges included in the 15.2 mi. of relocated trunk line between Cambridge and Concord two eliminate highway crossings at grade, three pass over railroad tracks and two are river crossings. The types of structure include rigid-frame concrete arch, multiple short spans on concrete piers and abutments with steel frame and concrete beam and slab decks, and reinforced concrete arch. The Sudbury River crossing is a concrete arch with a facing of light gray granite.

Under P.W.A. regulations limiting common labor to 30 hr. per week the contractors operate two daily shifts of 6 hr. each, 5 days each week.

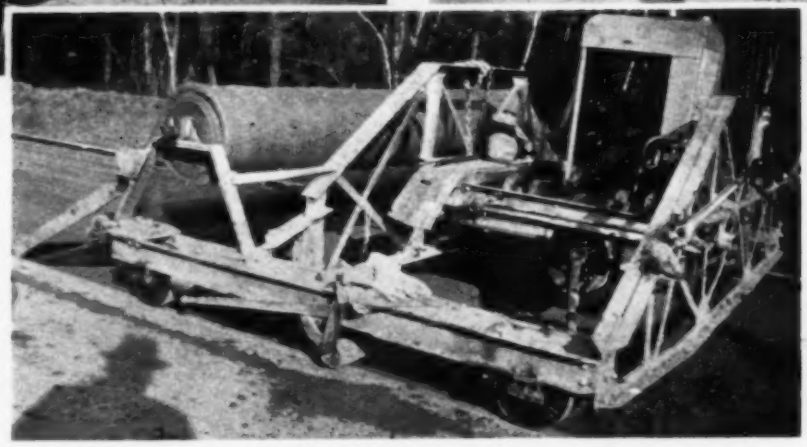
Personnel — For the Massachusetts Department of Public Works Arthur W. Dean, as chief engineer, directs all of the state's highway construction. The Cambridge-Concord highway is within the jurisdiction of the department's Brighton (No. 4) District with F.D. Sabin serving as district engineer, and E. R. Boucher, senior construction engineer, in immediate charge of the job.

For B. Perini & Sons, Inc., contractors, of Framingham, Louis Perini, president, exercises general supervision over the work on Sections 1, 3, 4 and 5, with John Doherty as general superintendent. The George A. Fuller Co. of Boston, was represented on Section 2 by William Godson, superintendent. For Warren Bros. Co., of Cambridge, C. Allen acted as superintendent on its separate bridge contract in Lexington.

FLEET OF TRUCK MIXERS *(below)*, each with a capacity of 5 cu.yd., delivers concrete for four-lane pavement at westerly end of project.

SIDE DISCHARGE from truck mixer delivers concrete into mechanical spreading machine.

MECHANICAL SPREADER, mounted on wheels, receives concrete from truck mixers and distributes it uniformly across 10-ft. width of subgrade.



JUTE FABRIC for "sheet" concrete pavement is unwound on to surface of base course concrete from roll on traveling steel frame.

Getting Down to

DETAILS

[Close-up Shots of Highway Job Methods and Equipment]

COMBINATION SPREADER AND FINISHER receives and strikes off hot-mix asphaltic concrete for three courses of paving project built by C. C. Robinson, Swingle & Robinson, General Construction Co., of Columbus, Ohio, for Ohio Department of Highways. Trucks dump into receiving box of Jaeger combination machine. Asphaltic concrete is distributed across 20-ft. pavement by two independently operated screws, and material is struck off by oscillating screed or by adjustable strike-off plates attached to it. Full description of this project will appear in an early issue of *Construction Methods*.

SPONGE-RUBBER EXPANSION-JOINT FILLER is inserted into preformed gaps in concrete pavement with aid of special tools. Ohio Department of Highways installs Goodrich sponge-rubber joints in 2,000 ft. of highway near Kirtland, Ohio. Filler is made in folded *(right)* and rectangular *(above)* types, each of which is installed with appropriate tool.

THE LONG AND THE SHORT OF IT. With a span of 30 ft., a Blaw-Knox gasoline-electric finishing machine *(left)* operates on a three-lane concrete pavement built by Berns Construction Co., of Indianapolis, for Indiana State Highway Department on U. S. Route 40, east of Cumberland, Ind. In contrast with this equipment is the 4-ft. wide Flex-Plane finishing machine *(right)* operated in Ohio by S. Monroe & Son Co. during the widening of an existing 16-ft. state highway at Lexington to a 20-ft. width by the addition of a 4-ft. strip on one side only.

ROUNDED SLOPE TOPS along highway cuts are obtained by the California Division of Highways with the aid of light, adjustable wood templet. It consists of four pieces of 1x2-in. lumber, 6½ and 7 ft. long, bolted together to form two triangles whose shape can be changed by loosening the two bolts which operate in slots 9 in. long in the lower ends of each leg. Arrows indicate points of contact when earth is shaped to proper curve. Rounding of top prevents raveling of slope and gives nicely finished appearance to highway cuts.

PICKUP AND LOADING MACHINE, designed by C. J. Chaffins, maintenance engineer, Washington State Department of Highways, clears excess material from road shoulders or ditches, loads from stock piles into trucks and removes surplus earth in fine grading. It consists of elevating bucket line suspended at side of truck with transverse conveyor belt which carries load to point of discharge into truck alongside. The department, Director L. V. Murrow reports, has cleaned 200 mi. of highway ditches economically with this machine.

PORTABLE GRAVEL LOADING PLANT of S. F. Ronde, Sheridan, Wyo., is supplied by Cletrac tractor hauling Killifer scraper to point of discharge over belt conveyor. From screening and crushing equipment second conveyor delivers to elevated steel bin which loads motor trucks below it.

ROUGHENED CONCRETE BASE, *(left)*, insuring bond for sheet asphalt surfacing, is produced on section of City Line Ave., Philadelphia, by dragging heavy chain *(above)* across freshly poured concrete. Workers of Eastern Asphalt Co., standing on timber bridges spanning slab, score concrete of 9-in. thick base with ridges and valleys formed by links of chain, which is pulled by two men across pavement in long loop.

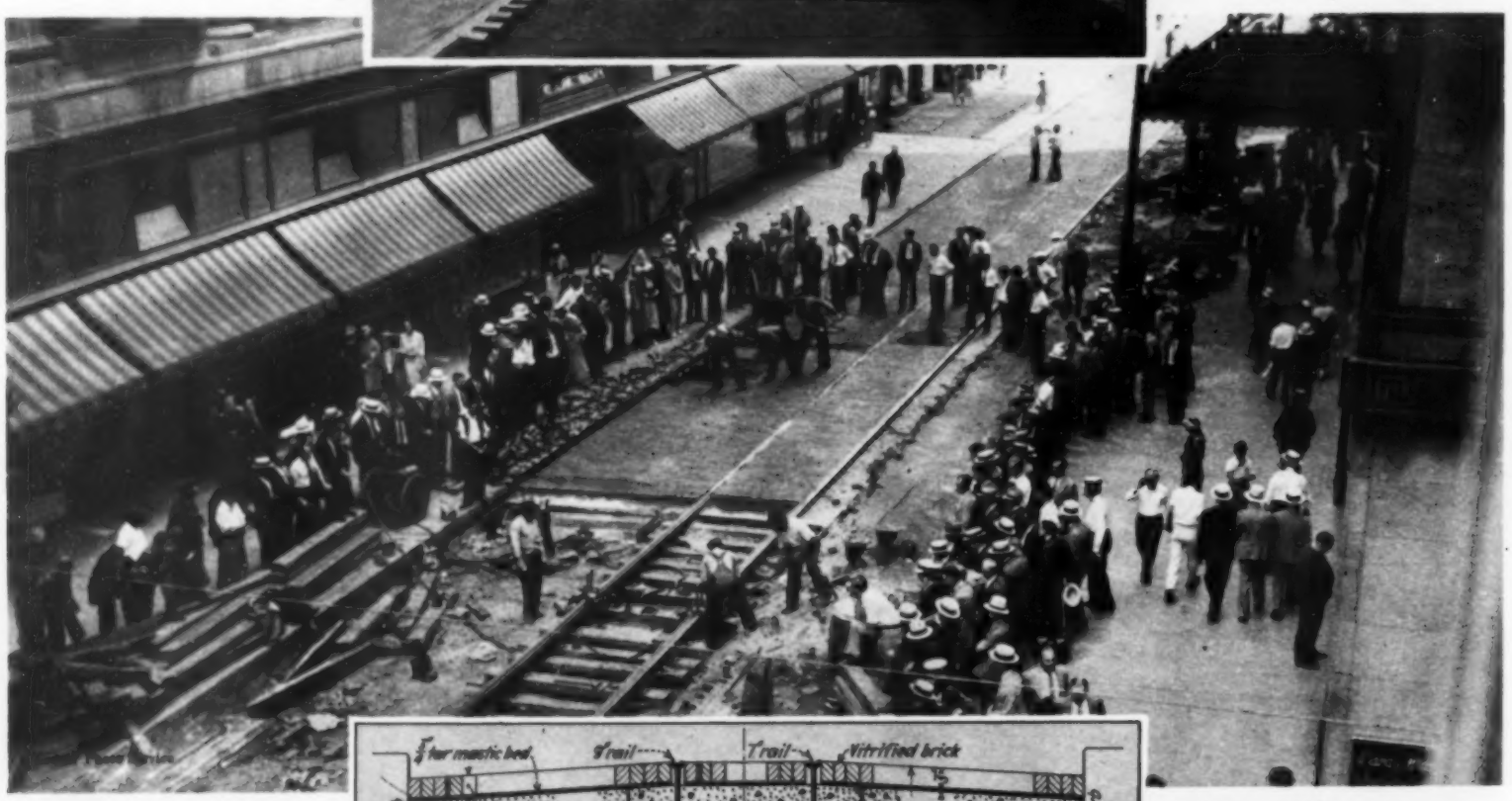
ROAD SHOULDER MAINTENANCE in Texas is not interfered with by this type of removable mail box support on R.F.D. routes. Wood post *(right)* is embedded in heavy octagonal concrete base block which, during shoulder maintenance operations, allows the mail box unit to be rolled out of the way *(above)* and replaced in upright position when the road crew has completed its work.

Philadelphia Streets Paved With

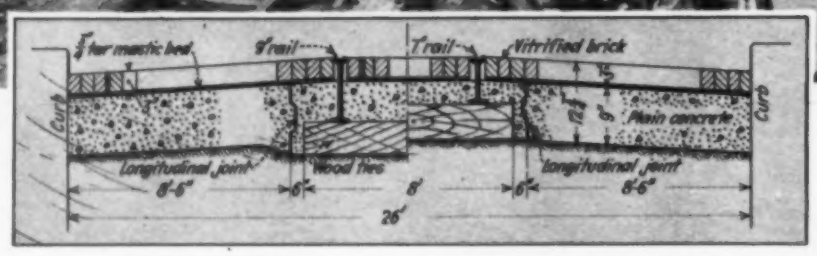
DE-AIRED BRICK

DE-AIRED vitrified brick, product of an improved manufacturing process employing a vacuum chamber to increase the density and uniformity of the clay mixture by removing air from it before it reaches the kiln, is the material with which the Pennsylvania Department of Highways has repaved, as NRA municipal projects, two sections of Philadelphia's busiest thoroughfares, Chestnut and Walnut Streets. From the construction point of view the paving operation was complicated by the fact that these two streets are the city's principal business arteries; each is narrow, with a width of only 26 ft. between curbs, and carries a street car track in the center, in addition to concentrated and continuous motor vehicle traffic. Removal of the existing wood block and granite block surfacing and replacement with new brick paving of modern design on a concrete base had to be done without preventing the passage of the surface cars of the Philadelphia Rapid Transit Co. which, at periods of peak traffic, operate at a frequency of about 70 per hr.

TAR-MASTIC BEDDING COURSE *(left)* supports brick on 9-in. concrete base.



REPAVING CHESTNUT ST. with de-aired brick. Street is 26 ft. wide between curbs and carries car track. Crew is scraping excess joint filler from paved section.



CROSS-SECTION *(left)* of brick pavement, showing ¾-in. tar-mastic bedding course and 9-in. concrete base.

On Chestnut St. the repaving extended from 5th to 22nd Sts., a distance of 6,991 lin. ft. and on Walnut St. from 6th to 22nd Sts., a distance of 7,184.5 lin. ft. The contractor for both projects was Francis A. Canuso & Sons Co., of Philadelphia.

Modern Design—The resurfacing of these two Philadelphia streets is representative of advanced practice in brick paving. In addition to the use of de-aired brick to insure uniformity and a high degree of resistance to wear by the finished surface, the bedding course is composed of tar-mastic, instead of ordinary sand, the concrete base is provided with longitudinal joints, and a clean finished pavement is produced by spraying the brick surface with a solution of calcium chloride prior to the application of the asphaltic joint filler in order to prevent adhesion of the excess filler to the pavement and allow it to be "peeled" off with scrapers and reused with an admixture of fresh asphalt.

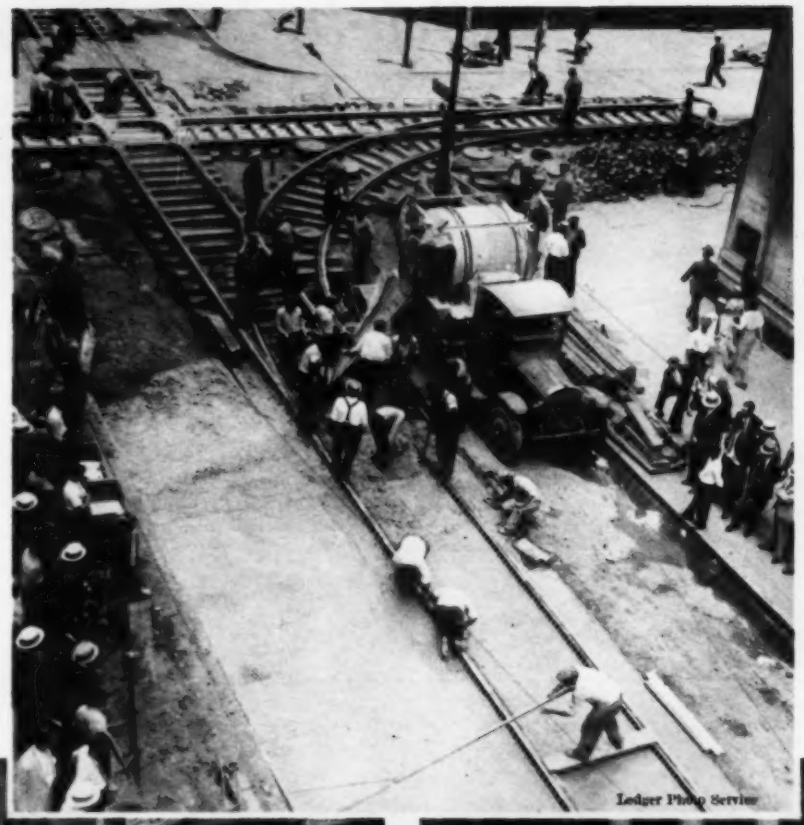
The pavement design specifies a plain concrete base 9 in. thick and 26 ft. wide, divided, longitudinally, into three slabs, the center one, under the car tracks, being 9 ft. wide and the two side slabs each 8 ft. 6 in. wide. Between adjacent base slabs are metal-type longitudinal joints, forming a tongue-and-groove connection, as shown in the accompanying illustration.

Upon the concrete base course is spread a ¾-in. thick tar-mastic bedding course supporting a 3-in. thickness of brick paving with bituminous joint filler. The street railway car tracks consist of steel rails either 7 or 9 in. deep carried on 9x5-in. by 8-ft. wood ties embedded in the concrete base.

The brick specified are wire-cut, vertical fibre lug blocks 4 in. wide, 8½ in. long and 3 in. deep, with tolerances of ¼ in. in length and ⅛ in. in width or depth. One side of each block carries two ⅛-¼-in. lugs, 1 in. in length, while the ends are double-beveled or bulged ⅛ in. in order to provide space for the access of hot bituminous filler in the end joints. For the brick an abrasion test loss not exceeding 17 per cent, by weight, is specified.

De-aired Brick—The object of the de-airing process in the manufacture of paving brick is to produce a clay mix-

ture of greater density and uniformity than was possible without this improvement. The equipment consists essentially of a vacuum chamber in which air is removed from the clay just before it is extruded in the form of a continuous "column" from the die of the brick-making machine. Among advantages in the finished paving brick resulting from the de-airing process are a heavier, more uniform, denser and more wear-resistant product, whose porosity is considerably less than that of ordinary brick. At the present time 14 brick manufacturers have equipped 16 plants to produce the de-aired paving block. A canvass of their experience with de-aired brick shows a decrease ranging from 2 to 6 points in rattler loss, a striking increase in the percentage of No. 1 brick (meeting requirements of the American Society for Testing Materials) procured from the kilns, greater uniformity of product, and an increase of from 2 to 5 per cent in weight. Gen-



the brick for the wearing course.

Brick were laid upon the bedding course with the better wire-cut face uppermost and with lugs all in the same direction. After inspection and sweeping the surface was rolled with a 6-ton roller. Then came the application of calcium chloride to the surface to prevent the adhesion of excess joint filler. The solution was mixed in the proportion (by weight) of 35 per cent calcium chloride, 1 per cent starch and 64 per cent water. Pressure sprayers, with nozzles on the ends of short hose lines, applied the solution, vertically, to the brick surface in the form of a fine mist. Care was exercised to direct the spray straight down, so as to confine its coverage to the tops of the brick and prevent its entry into the joints and along the sides of the blocks with which the asphaltic filler, later, was to bond.

CONCRETE FOR BASE *(left)* **is delivered by transit mixer and chuted to place. Car tracks complicate paving operations.**

CALCIUM CHLORIDE is sprayed on brick surface to prevent adhesion of excess joint filler.

ASPHALT JOINT FILLER, delivered by two-wheeled buggy, is flushed into place.

EXCESS FILLER is easily scraped off, leaving clean, skid-proof brick surface for use of traffic.

eral opinion of the manufacturers is represented by statements of several of their number to the effect that the de-airing process produces at no increase in cost, a brick of more uniform quality, better appearance, denser, less porous, more resistant to wear and higher in both crushing and tensile strength than heretofore.

Bedding Course—In addition to the improved feature of longitudinal joint construction in the concrete base of the brick pavements in Philadelphia the tar-mastic bedding course reflects the trend away from the ordinary sand cushion of former years. Experience showed that ordinary sand shifted under the brick and filtered into cracks and joints in the base, causing settlement and depressions in the paved surface. The bituminous mastic material, however, overcomes these objections by compacting readily and bonding sufficiently to prevent shifting or filtering into cracks.

On the Chestnut and Walnut St. projects the ¾-in. bedding course employed consisted of from 92 to 95 per cent sand (all of it passing a No. 8 laboratory sieve and not more than 8 per cent passing a No. 100 sieve) and from 5 to 8 per cent tar having a viscosity of from 14 to 22.

Specifications for the joint filler called for an asphalt of 30 to 40 penetration (at 25 deg. C., 100 g., 5 sec.) which would not foam when heated to 200 deg. C.

Construction Methods—Concrete for the 9-in. base course, a 1:2:4 mix, was delivered by side-discharge transit mixers and carried to place on the subgrade by a short length of inclined metal chute. Screeding was done by hand. The use of a high-early-strength cement for the base concrete made it possible to spread the tar-mastic bedding course and proceed with the laying of the brick without the delay incident to a long curing period.

Sand and tar for the bedding course were prepared in a batch mixer and after the top of base had been thoroughly cleaned by sweeping, the mixture was spread to a depth of ¾ in. and struck off accurately to cross-section contour with templates, ready for the laying of

After the application of this surface adhesion preventive, hot asphalt joint filler (at a temperature of from 350 to 450 deg. F.) was poured on the brick surface from 2-wheel concrete buggies and flushed into the joints. After the joint had been completely filled and the asphalt had cooled, the excess filler, in the form of a mat on the surface of the brick, was scraped or "peeled" off with flat-bladed spading tools or sidewalk scrapers. This salvaged material was removed and reheated in the asphalt kettles with at least 25 per cent of fresh material and again applied as joint filler, thereby effecting a considerable saving in the quantity of asphalt filler required and at the same time producing a clean brick surface free from excess asphalt.

Personnel—The repaving of Chestnut and Walnut Sts. in Philadelphia was done under the direction of the Pennsylvania Department of Highways, of which Samuel Eckels is chief engineer. N. A. Staples is district engineer and E. Y. Schenck, assistant engineer in charge of construction. The contractor was Francis A. Canuso & Sons Co. of Philadelphia.

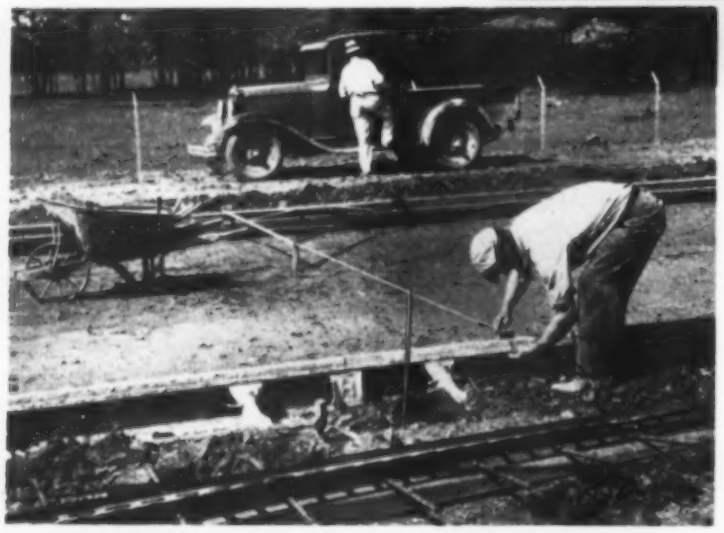
Step-by-Step Field Methods

Installing Copper-Sealed Joints in Concrete Pavement

1 PREFABRICATED COPPER - SEALED JOINTS distributed with accessories in crates along shoulder are assembled with bar steel in units ready for installation. After inserting dowels through ferrules in body of air-cushion expansion joint, two men, using crate as bench, place joint in upside-down position and adjust dowels until they extend equal distances on both sides of body. Wire brackets then are slipped into place and metal socket caps placed on alternate ends of dowels. These ends are given a coat of heavy grease. Load-distribution bars are wired to dowels. Assembled joints, ready for installation, are distributed along shoulder.

REPRESENTING ILLINOIS DIVISION OF HIGHWAYS. (Left to right) Paul W. Wood, resident engineer; James R. Nevin, inspector; George Bohlig, district materials engineer, and R. H. Tittle, district construction engineer, District 1, Elgin, Ill.

2 RIGHT-ANGLE TRIANGLE *(right)* squares up position of chalk line at joint location. Templet made of light angles is handled easily by one man.



3 CHALK LINE is stretched over two wooden blocks on road forms. Height of blocks is equal to pavement crown.

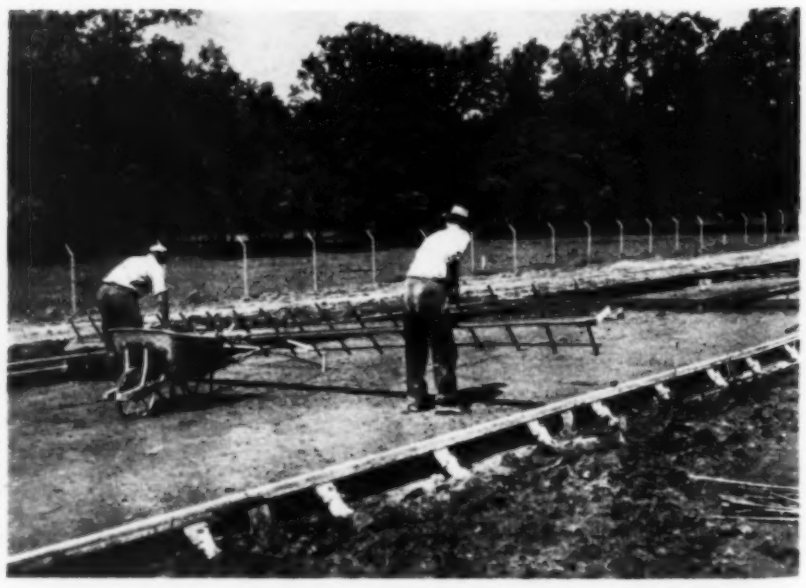
IN A 4-MI. contract for two 20-ft. concrete roadways of 10-8-10-in. cross-section separated by a 30-ft. park strip on the new Skokie highway, replacing an inadequate parallel route 25 mi. north of Chicago, near Waukegan, Ill., the Chicago Heights Coal Co., experienced road-building contractor, installed copper-sealed expansion joints, contraction joints, and longitudinal center-line joints in accordance with the specifications of the Illinois Division of Highways. The pavement design called for a 1-ft. curb along each roadway adjacent to the park strip and provided a keyway in the outer edge of each slab for future widening.

Expansion joints of air-cushion type ¾ in. thick were incorporated in the pavement at 90-ft. intervals, with transverse contraction joints at 30-ft. spacing between expansion units. The transverse contraction joints and the longitudinal center-line joints were constructed with deformed steel-plate strips similar to those which have been used for years for center-line joints in certain states. All the joints varied from ordinary design in that they embodied at the top a seal of copper plate with horizontal wings which became embedded in the slabs on the two sides of the joint. The seals were designed to respond with hinged action to the movement of the slabs throughout the life of the pavement.

Joints for all three purposes were received on the job in prefabricated units packed in crates with all accessories except steel bars. Two men assembled the joints complete with steel dowels, tie-bars, and load-distribution steel, and two additional men installed the assembled units on the subgrade in advance of the paving mixer, which traveled on the shoulder outside the forms. The four-man crew easily took care of joint assembly and installation for average runs of 1,100 lin.ft. per 12-hr. day.

Joint Design—Accompanying photographs serve to bring out the most im-

4 COMPLETE JOINT UNIT *(below)* of air-cushion type is placed on subgrade in position marked by chalk line. Two men easily handle 20-ft. joint without danger of deformation.



5 TAPERED STEEL PINS are driven through perforations in wings of copper seal. Beveled edge of pin, turned away from joint, forces pin tight against joint. Methods of installation are similar for expansion joints and transverse contraction joints, one of which is shown here.

portant features of the three kinds of Ace joints utilized by the contractor on this project.

Essentially the expansion joint consisted of a metal stool of 26-gage steel, shaped somewhat like an inverted U, supporting a copper seal and a bituminous cap. The stool had turned-out flanges which rested on the subgrade, and the copper seal (of hairpin cross-section) was designed with perforated wings which became anchored in the concrete slabs. A premolded asphaltic composition cap, cemented and wired to the copper seal, protected the top of the unit in transit, served as a guide in finishing the slab, and remained

8 TUBULAR TEMPLET guides setting of center-line joint 10 ft. from edge of pavement. Joint installation is completed some distance ahead of paving mixer, which travels on shoulder. This method of construction saves labor on joint installation but does not accelerate job progress, according to contractor.

6 DOWEL-BAR CHAIRS are slipped on ends of dowels at intervals to support bar steel parallel with subgrade and forms.

with the center section die-stamped to the shape of a half-trapezoid. The steel strip had a right-angle bend at the base to support the joint on the subgrade. Openings in the web spaced at 1-ft. centers provided for insertion of slip dowels. At the top, the body of the joint supported a seal of 16-oz. copper, bent into a hairpin fold with horizontal perforated wings similar to those of the expansion-joint seal. A special bead at

IN CHARGE OF JOB. (Left to right) W. J. Orr, secretary, Chicago Heights Coal Co.; Paul W. Wood, resident engineer; and T. O. Peter, superintendent.

7 NOTCHED BLOCK *(left)* checks crown of joint against chalk line. Notches are stepped to give proper interval between chalk line and joint at center line, quarter-points and forms.

permanently in place as an integral part of the joint. The cap was designed with a taper toward the top to prevent extrusion. Ferrule spacers in the stool at 1-ft. intervals served both to prevent deformation of the sheet metal walls during installation or concreting and to permit insertion of load-transmission dowel bars.

Transverse contraction joints were formed of crimped 26-gage steel strips the top of the seal was designed to preserve the flexibility of the seal and to insure the permanence of the hinge action during the life of the pavement.

In the longitudinal center-line joint, the body and seal were similar to those of the transverse contraction joint. Steel clips, sprung into place, connected adjoining sections.

Batches of concrete were not dumped directly on the joints. Instead, the concrete was shoveled against the two sides of each joint in such a way as to maintain equal opposing pressures. Careful spading with a bladed tool consolidated the concrete on both sides of the joint.

MILE-A-DAY *is Progress Rate for Road-Mix Produced by Moving Train of Special Equipment*

CLYDE W.("Mile-a-Day")WOOD, contractor, of Stockton, Calif., in front of last unit of road mix equipment train, a 6,000-gal. tank trailer from which road oil is pumped into continuous mixer ahead of it.

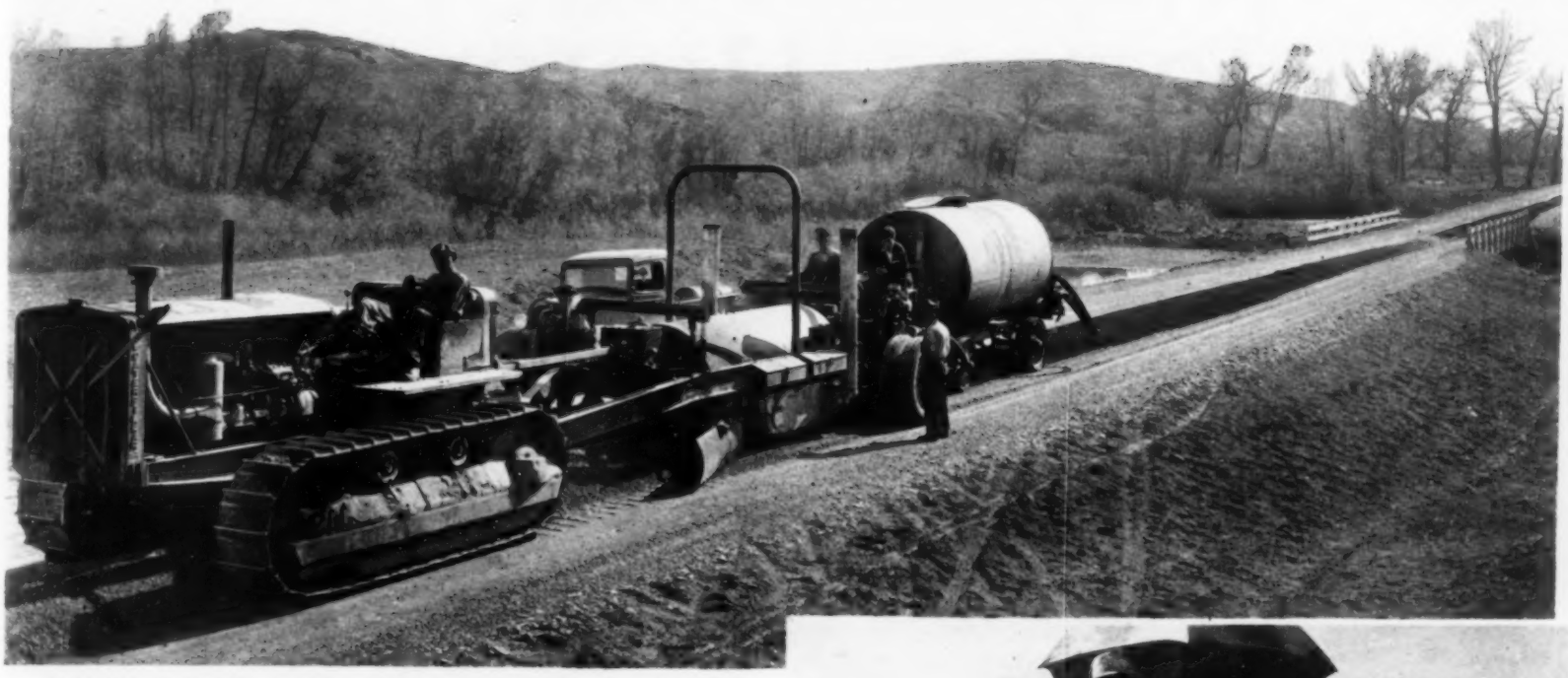
MILE-A-DAY progress in the construction of highways of the bituminous road-mix type is the mark which Clyde W. Wood, contractor, of Stockton, Calif., shoots at and hits with the train of special equipment, moving at constant speed, which he has developed to pick up aggregate spread in a windrow of measured volume on the subgrade, pass it through a continuous mixer where asphaltic road oil is introduced in predetermined amounts and discharge it in a steady stream from the rear end of the plant ready for final spreading and shaping with blade graders and rollers. The moving plant, hauled by a 75-hp. tractor which, through a special transmission, supplies power to the mixer element of the train, is designed primarily to meet the need for the speedy construction, at low cost, of a bituminous mat on secondary roads to replace existing waterbound macadam or gravel surfacing, and at the same time insure an accurate, instead of a haphazard, control over the proportioning of the ingredients of the continuous mix in which native materials, either on the existing road surface or from nearby borrow-pits, are used, where possible, for the aggregates.

MIXER UNIT, of continuous type, receives aggregate scooped up from measured windrow on subgrade. In upper right corner note end of power transmission unit operating mixer from tractor.

TRACTOR equipped with special transmission and power unit hauls equipment train at constant speed of ¼ mi. per hour and operates mixer unit in center.

Windrow Proportioner—First in the train of equipment employed to build—usually in half-widths—these road-mix highways, is a unit known as a windrow proportioner. This machine, as its name implies, is designed to distribute along the subgrade a continuous ridge of aggregate accurately shaped to contain a predetermined uniform volume of material per linear foot of road. It consists of two blades mounted at an angle on the frame of an ordinary grader, in place of the regular blade, so as to bring the material to the center and allow it to pass out, at the rear, through an orifice whose size is determined by the amount of material per linear foot needed for the half-width bituminous mat. Excess material is carried along in the proportioner to those spots that are deficient in aggregate. The volume uniformity of the unmixed windrow thus produced is indicated in one of the illustrations.

Next in the sequence of operations comes the mixer train proper, consisting of a tractor, pickup scoop, continuous mixer and oil tank trailer. Obviously, to obtain uniformity of mix by this method, it is essential that the plant travel at constant speed and that road oil be fed into the mixer at a constant rate. Power is taken from the tractor through a special transmission and power unit which operates the continuous mixer and also converts the speed of travel of the tractor from a maximum high



MOVING PLANT forms train consisting of tractor, continuous mixer and 6,000-gal. road oil tank-trailer. Windrow of mixed material is deposited continuously from rear of outfit, ready for spreading and rolling.

speed of about 6 mi. per hour to a minimum speed of ¼ mi. per hour, which is the standard rate at which the outfit moves along the subgrade. At this rate the plant, in an 8-hr. day, covers 2 mi. of half-width contruction or 1 mi. of full-width roadway, a performance that has earned for its maker the sobriquet of "Mile-a-Day" Wood.

Mixer—The mixer unit operates on the general principle of the old continuous concrete mixer, supplemented with cutting wings and cutting edges under the drum to collect the material and bring it within reach of the rotor and the oil supply. Aggregate from the windrow of uniformly measured volume enters the mixer through a mouth equipped with a shovel-like scoop which picks up the material as the plant is hauled forward. After the road oil has been thoroughly incorporated with the mineral aggregate the mix is redeposited in a continuous windrow behind the moving machine.

The special transmission devised by Mr. Wood for a slow speed of travel makes most of the power of the tractor available for the operation of the mixer and by building operations around one motor it is possible to synchronize the working of the complete plant. Any possible excess material entering the mixer drum would slow down the rate of travel and permit extra road oil to be applied to the increased volume of aggregate.

Control—Road oil to supply the moving mixer is pumped from one or more 6,000-gal. tank trailers towed along at the rear end of the equipment trains. The rate of application of the road oil to the material in the mixer is indicated by a meter and a pressure gage. It is easy to make slight variations in the amount of oil used for the mix by increasing or decreasing the oil pressures through a relief valve in order to provide for variations encountered in the grading of the aggregates. Thus, with thorough machine mixing, far more accurate control of the mix is possible, it is claimed, than by ordinary mixed-in-place methods employing a blade grader to turn the oiled material over and over on the subgrade.

POWER TAKE-OFF from 75-hp. tractor operates mixer unit of equipment train.

The final operation in building the road is accomplished by standard patrol graders and rollers which distribute, shape and compact the windrow of machine-mixed material which issues from the rear end of the traveling plant. Last year about 500 mi. of road were mixed by the Wood type of plant, as compared with a mileage of 250 during the previous year. At the end of one year Mr. Wood reported 10 of these traveling road-mix outfits in operation on a royalty or subcontract basis, principally in Wyoming and Nevada, with other jobs in Nevada, Utah, Nebraska, South Dakota, Arizona and California.

MEASURED WINDROW of aggregate *(at left)* for half-width construction is straddled by tractor train which scoops material into continuous mixer. Mixed windrow at right.

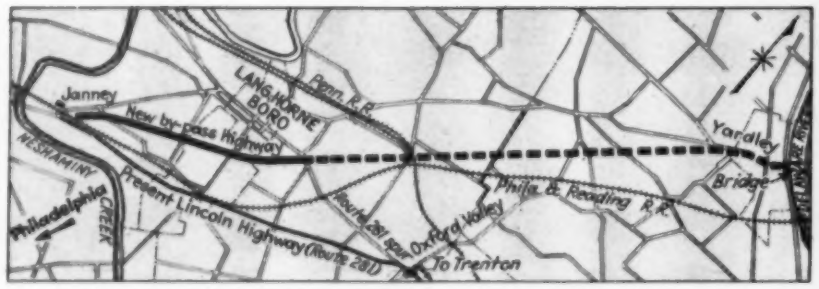
FROM REAR OF TRAIN continuous windrow of accurately mixed surfacing is deposited for spreading by blade grader and compaction by roller.

BYPASS HIGHWAY

Will Divert Through Traffic Around Philadelphia

WHEN the Pennsylvania Department of Highways completes its trunk-line project for a concrete-paved bypass road north of Philadelphia, through traffic between New York and points in the West and South, instead of having to pass through the streets of the city's business center, will be diverted around the metropolitan area and through the suburbs in Bucks and Montgomery counties. The new highway, therefore, will accomplish the dual purpose of saving time for through traffic and at the same time will relieve Philadelphia's streets of the congestion caused by vehicles entering the heart of the city to reach other points on east-west or southern routes.

Location—Located in Bucks county, the new bypass road, with improved alignment carrying grades not exceeding 4 per cent and curves of not more than 1 deg., parallels an existing portion of the Lincoln Highway (State Route No. 281) connecting Philadelphia and Trenton, N. J., and includes a total length of about 12.5 mi. extending in a northeasterly direction from the suburban area north of Philadelphia to the Pennsylvania-New Jersey state line at the Delaware River, where the road connects with a bridge to be built at Yardley, Pa., several miles north of Trenton, N. J. Similar bypass construction by the State of New Jersey will enable the extension of the route in a general easterly direction to pass north of, instead of through, Trenton, the state capital, thus speeding up the flow of traffic between Philadelphia and New York.

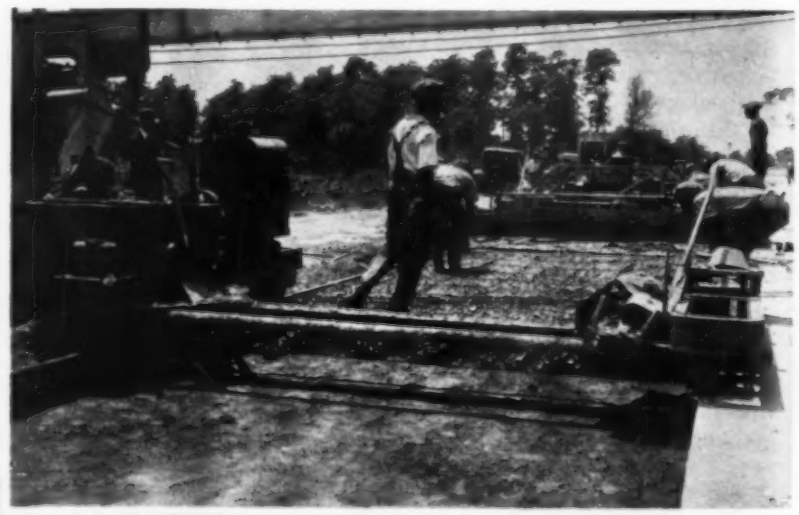


LOCATION OF BYPASS HIGHWAY to divert through-traffic around Philadelphia via northern suburbs.

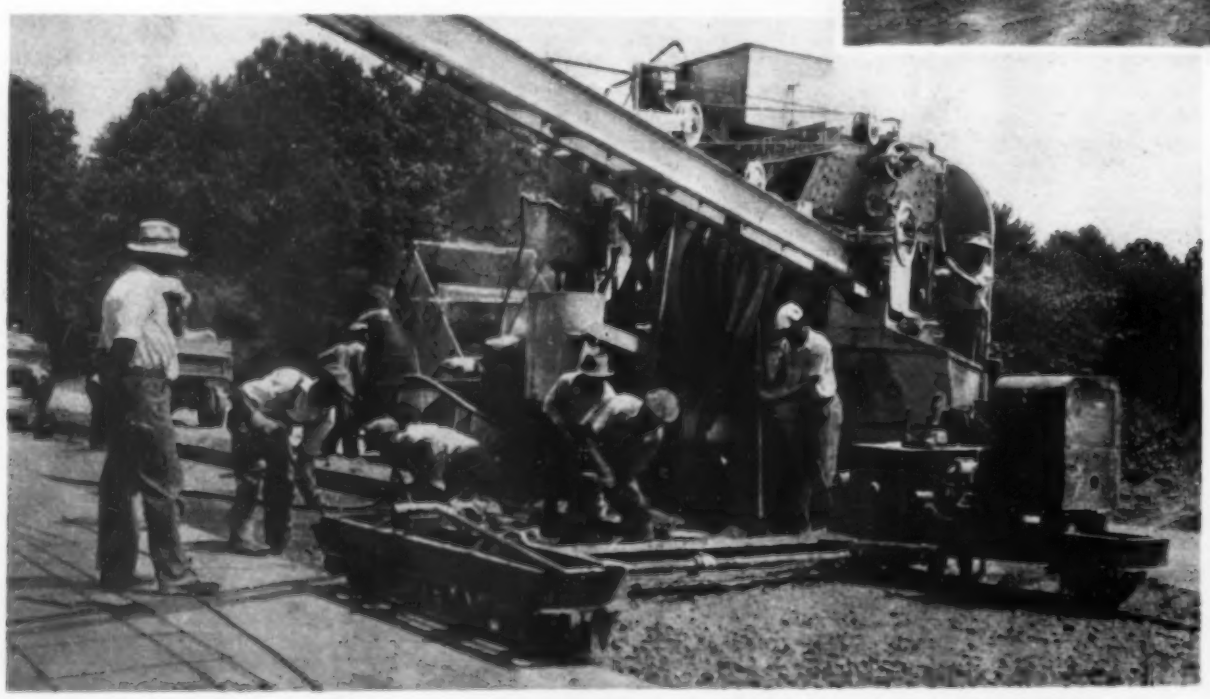
At its westerly end the new bypass highway will be provided with a connection via the existing Roosevelt Boulevard (U.S. Route No. 1) to City Line Ave., which is being widened and repaved as part of the broad project of serving traffic by a circumferential route swinging around to the north of Philadelphia's metropolitan area.

Design—The new bypass construction (of which a 2.45-mi. section was completed in 1933 at a cost of $346,000) is typified by the contract for an additional 3.02 mi. of the route awarded May 11, 1934 to Dalton Bros., Inc., of Paoli, Pa., at a price of approximately $270,000. The work, starting near the village of Janney and extending northeast to a point near Langhorne, consists of a graded width of 60 ft. carrying a 40-ft. reinforced concrete pavement, with 10-ft. shoulders at each side. The slab has a thickness of 8 in. at the center and 10 in. at the edges, following the Pennsylvania state 10-8-8-10-in. standard section, as illustrated in the accompanying drawing. The

VINCENT DALTON, in charge of job for Dalton Bros., Inc., contractors.



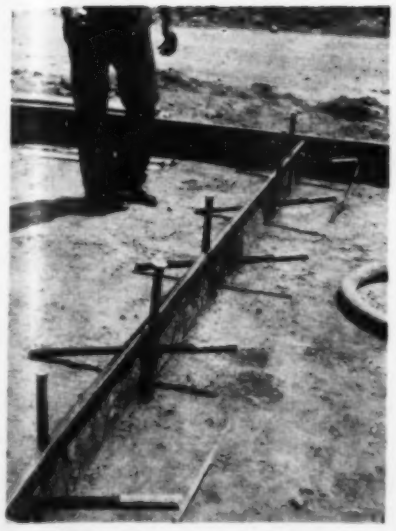
MECHANICAL STRIKE-OFF, riding on forms, levels concrete 2 in. below tops of forms to receive steel reinforcement.



PAVING MIXER, depositing concrete for 10-ft. slab, is followed closely by mechanical strike-off which, in turn, precedes finishing machine.

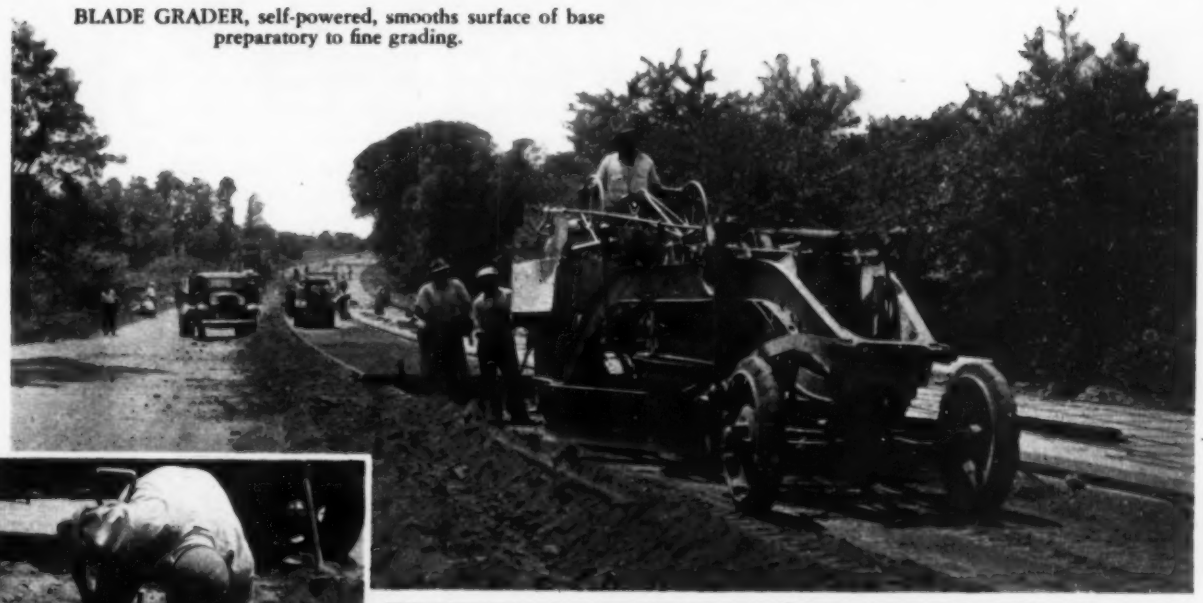
pavement is reinforced with steel bar mats placed 2 in. below its top surface and has a crown of 4 in. Construction is in 10-ft. lanes, with slip dowel transverse expansion joints spaced approximately 75 ft. apart.

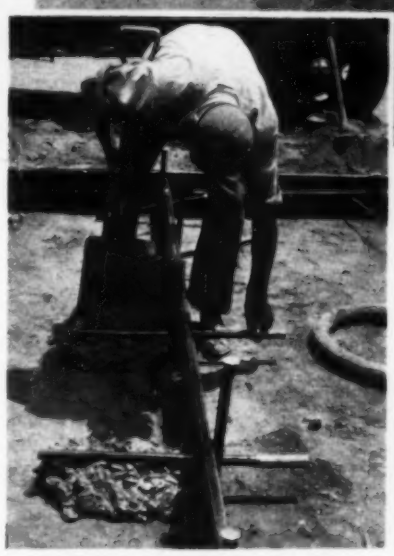
Joints—Each transverse joint for a 10-ft. wide slab consists of ¾-in. thick strip of premolded joint material pierced by five 1-in. circular steel bar dowels, each 2 ft. long, located at the center of the slab depth. One-half of the length of each dowel bar is coated with asphalt to break its bond with the concrete of the adjacent slab, while the other half is solidly embedded in the concrete; the end of each oiled half of the dowel bar is capped with a 4-in. long paper tube containing a 1-in. long cork in its closed end to form a positive spacer for a



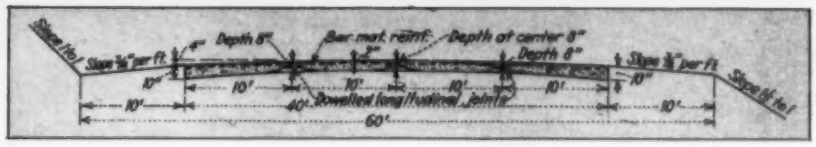
DOWEL BARS are inserted through premolded strip at transverse joint.

BLADE GRADER, self-powered, smooths surface of base preparatory to fine grading.





LEVELING UP of dowel bars is done by depositing shovelful of wet concrete.



CROSS SECTION of Pennsylvania standard concrete pavement.

PAPER TUBE *(below)*, 4 in. long is used to cap one end of each dowel bar, providing recess for expansion.

clearance pocket, allowing for the movement, due to temperature changes of the slab, of the dowel bar within the concrete.

Longitudinal joints between 10-ft. slabs are of the keyed type with ½-in. dowel bars extending between adjacent slabs, as illustrated in the accompanying photographs. In forming these joints ,Truscon sheet metal joint plates, bent to proper shape, are attached by clips to the inside faces of the road forms, so that when concrete is poured against them they mold a notch ¾ in. deep and 2½ in. wide along the longitudinal face of the slab with which the concrete for the adjacent parallel slab, when poured, forms a key. These sheet metal joint plates are slotted to receive transverse dowel bars which are bent at their midpoint to lie in the groove behind the form during pouring and later are straightened out so as to extend horizontally into the adjacent slab.

Concrete—Concrete specifications require a 1:2:3.5 mix, by weight, and a water content not exceeding 5.5 gal. per bag of cement. The mixing time is set at a minimum of 1¼ min. per batch. As actually produced on the job the batches were mixed in the proportions of 94 lb. of cement, 206 lb. of sand and 350 lb. of coarse aggregate.

To assist the curing of the concrete, calcium chloride, in solution, at the rate of 2 lb. per bag of cement, was introduced into each batch at the mixer.

Paving Operations—In constructing the pavement Dalton Bros., Inc. used a standard 27-E Ransome paving mixer served from a central batching plant at South Langhorne, on the Philadelphia & Reading R. R., by a fleet of 8 Ford and Chevrolet trucks, each hauling 2 batches per trip. Light trucks were preferred to heavier units on this job because of their flexibility, ease of turning and ability to come well within the maximum axle load regulations for all vehicles, rigidly enforced by the state police patrolling the highways.

After the heavy grading work had been done the subgrade was first roughly shaped with a gasoline-powered blade machine and finished to final shape by hand labor and a light roller. The contractor's plan of operations provided for keeping at least 1,000 ft. of prepared subgrade ahead of the forms and the forms, in turn, set for a distance of 1,500 ft. ahead of the mixer. A normal day's paving was 1,200 ft. of 10-ft. slab in 10 hr.

Mixer Details—The paving mixer was equipped with a special device to add calcium chloride in liquid form to each batch. On the side of the machine was mounted a tank in which was mixed a concentrated solution of 100 lb. of calcium chloride to 13 gal. of water. From an opening in the bottom of this tank a short length of flexible rubber hose led to a small cylindrical closed tank mounted on the side of the loading skip, as illustrated. This small tank was designed to hold just enough of the concentrated solution to apply the chemical to each batch at the desired rate of 2 lb. of calcium chloride per bag of cement. With the mixer skip in loading position a charge of the calcium chloride solution ran by gravity into the small closed tank and when the skip was raised into position for discharging, the solution flowed out from the small tank (now elevated to a considerable height) through a second hose line leading directly into the mixer drum. In this way the feed of calcium chloride in proper amounts was made automatic.

Another detail of the mixer consisted of a steel baffle plate extending entirely across the open end of the loading skip

INSTALLATION OF JOINTS, both transverse and longitudinal, is complete ready for pouring of 10-ft. concrete slab.

JOINT PLATES are attached by clips to inside faces of forms for longitudinal joints.

LARGE CALCIUM CHLORIDE TANK *(at top, right)* feeds small cylindrical tank on side of mixer skip.

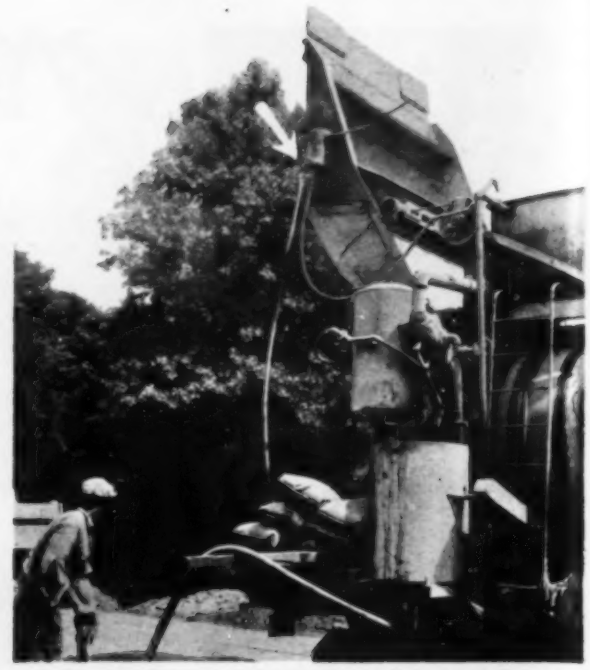
and about 1 ft. in from its outer lip. This plate, extending down to the floor of the skip, served two useful purposes. As illustrated herewith, it prevented the rear wheels of the batch trucks, backing up to discharge their loads, from entering too far into the mouth of the skip and damaging it. Also, it prevented portions of the dry batch, as it was dumped from a truck, from spilling out of the end of the skip and on to the subgrade. In Pennsylvania this latter point is important as the state highway department regulations, in order to prevent the introduction of earth or other foreign matter into the mix, prohibit a contractor from shoveling back into the mixer skip any aggregates thus accidentally spilled on the subgrade.

Strike-off and Finishing — As the paving mixer deposited its batches upon the prepared subgrade it was closely followed by a self-powered mechanical strike-off machine, which leveled off the concrete 2 in. below the elevation of the finished pavement to permit the placing of the steel bar reinforcement mats.

Behind the strike-off unit a double-screed Lakewood finishing machine completed the paved surface in two passes. Final operations consisted of testing the surface with long-handled straightedges, followed by the application of a burlap or denim drag. In Pennsylvania the practice of brooming the surface of the green concrete is omitted.

Curing—For purposes of curing, the slabs were covered by Burlington blankets in the form of 6x12-ft. sheets of cotton ply sandwiched between coverings of burlap. These blankets were thoroughly wetted down before placing and allowed to remain in place 24 hr. in a saturated condition before being stripped off, piled upon a four-wheeled carriage riding on the forms and relaid upon a new section of green concrete. With this method of curing as a supplement to the integral use of calcium chloride in the concrete mix, the concrete passed the required beam strength test of 500 lb. per square inch in a period, usually, of from 7 to 9 days, as compared to a period of about 21 days during which traffic had to be kept off the pavement when ordinary moisture methods of curing were employed.

Personnel—For the Pennsylvania Department of Highways, of which Samuel Eckels is chief engineer, the construction of the Philadelphia bypass highway was under the supervision of N. A. Staples, district engineer, with C. J. Guldin in immediate charge as assistant engineer of construction. Vincent Dalton superintended operations for Dalton Bros., Inc., contractors, of Paoli, Pa.



WHEN SKIP RISES small calcium chloride tank empties measured charge through hose line into mixer drum.

C. J. GULDIN, assistant engineer of construction for Pennsylvania Department of Highways.

FINE GRADING is checked with toothed subgrade tester of sturdy all-metal construction.

TRANSVERSE PLATE in mouth of mixer skip bars truck wheels and prevents spilling of aggregates on subgrade.

CURING BLANKETS of cotton ply between burlap covers are handled by 4-wheeled carriage riding on forms.

Roadside Treatment

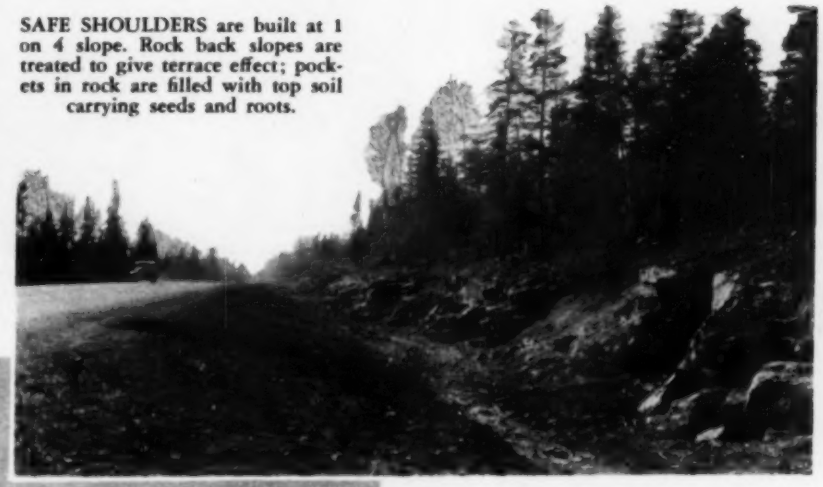
Beautifies Minnesota Route

A 10-MI. roadside development project which should give Minnesota an outstanding example of what can be accomplished by such work is under way on U.S. Highway 61 on the north shore of Lake Superior. The task will require a year for completion. While the state highway department planned the roadside activities, the work is being done by the Civilian Conservation Corps and the necessary materials are provided by the National Parks' Service. Practically no expenditure of state highway funds is required, according to N. W. Elsberg, highway commissioner.

The North Shore project begins near Lutsen and extends about 2 mi. north of Cascade. There, in a naturally wild and beautiful setting, closely skirting the lake shore, new ideas in highway beautification and safety are being put into practice. Steep side ditches and sharp, ugly cuts are being reduced to safe, gentle slopes covered with native ferns, wildflowers and other wild vegetation of the countryside. The highway, instead of being a raw gash through the woods, is being made to harmonize with the scenery so that the edge of the right-of-way will blend imperceptibly with the wilderness.

Undesirable brush, dead wood and fallen trees are being cleared away along the roadsides. In some places carefully planned thinning of woods is carried out to open up vistas along trout streams or out upon the lake. In other spots native trees and shrubbery are planted. Guard rails of rustic construction are planned. At Cascade, where the Cascade River flows into Lake Superior, a roadside parking area large enough to accommodate 40 automobiles is being constructed. A native stone concourse will overlook the lake, while on the other side of the highway foot trails will lead back into the woods along the river banks.

The state owns 2,000 acres of land in the Superior national forest. A CCC camp is built at Cascade to house the young men engaged on the work. In addition to roadside activities they will construct a firebreak around the state land and build trails under the direction of the state conservation department. The CCC buildings are so planned that eventually they can be turned over to the conservation department for park and tourist use.



SAFE SHOULDERS are built at 1 on 4 slope. Rock back slopes are treated to give terrace effect; pockets in rock are filled with top soil carrying seeds and roots.

BEAUTY OF PINE CLUSTER is emphasized by clearing away young growth and underbrush.

GENTLE BACK SLOPE *(left)* **is planted with irregular groups of native evergreens as contrast to white birches in background.**

IN PLANTING young evergreens on flattened backslope *(below)* arrangement in regular rows is avoided.

ROADSIDE CONCOURSE, developed in rustic style, overlooks Lake Superior.

EYESORES *(below)* **like this are removed to open up lake vista.**

OLD STYLE BACKSLOPES *(left)* **are steep, bare and ugly.**

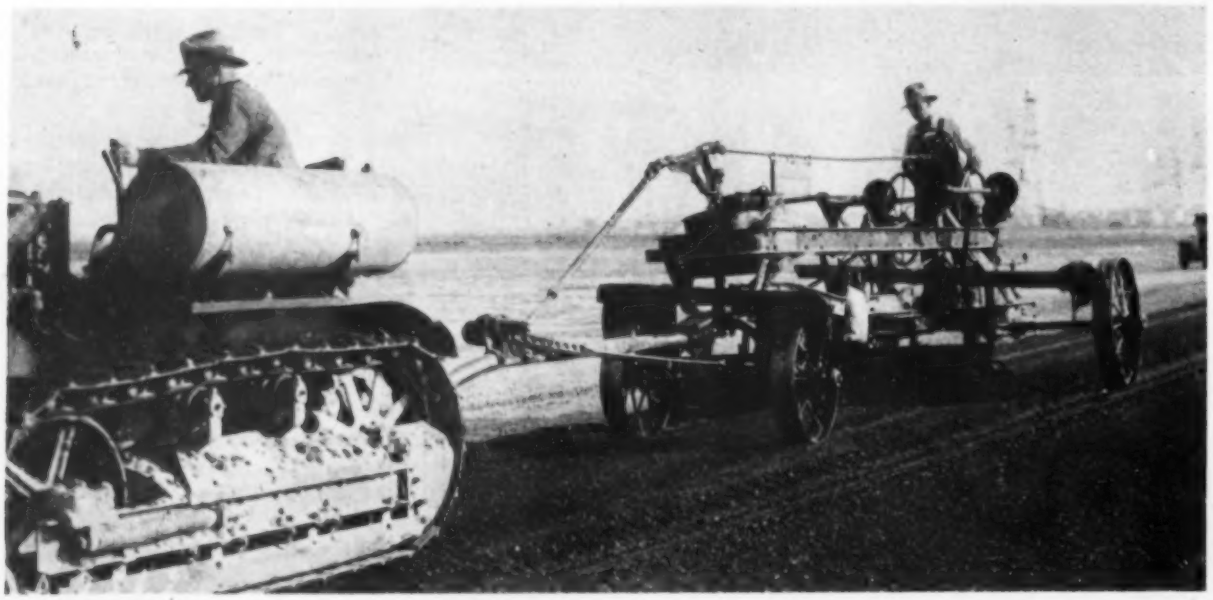
COLD-LAID Asphaltic Concrete

Paves 40-Ft. Road on Unstable Fill

BASE MIXTURE is dumped by trucks over marked distances on roadway to provide material for 2-in. compacted depth. Mixture is warm when delivered.

UNSTABLE SUBGRADE on a dredged fill across former salt marshes in Long Beach, Calif., led the California State Division of Highways to select a flexible, inexpensive pavement for a 6,600-ft. section of Hathaway Ave., which carries 8,000 vehicles per day, including many heavy trucks hauling to and from a producing oil field adjacent to the road. After a 6 months' test of 3-in. Laykold asphaltic concrete on the most unstable portion of the project, the district office at Los Angeles specified this material to be laid in two courses to an equal depth on a contract section 6,600 ft. long and 40 ft. wide. Separate bids were invited for mixing and placing, with the result that the Sully-Miller Contracting Co. was awarded the former contract at $2.30 per ton and the Griffith Co. received the latter at $0.513 per ton.

A severe earthquake with accompanying vibrations and movement of the fill intervened between the construction of the base and surface courses. Heavy rains occurred as soon as the base was finished, and the engineers decided to seal the base with Bitumuls and let traffic use it until dry weather favored resumption of the work. During this interval, the severe earthquake, originating within a few miles of Long Beach, rocked the fill and opened several transverse and longitudinal cracks in the base. With a small amount of maintenance the roadway was made passable for traffic, which utilized it for 2½ months more before the top course was laid.



TRACTOR-DRAWN BLADE spreads base mixture and strikes it off to required grade for rolling. Good blade operator obtains smooth surface.

FRESNO SCRAPER drawn by mule team aids distribution in front of blade grader and trims edges of paving strip.

SURFACE MATERIAL *(below)* is dumped in front of revamped bituminous surfacing machine which distributes and strikes off mixture to proper depth.

A careful survey after the quake showed that roadway settlement required an additional pavement thickness of ¾ in. to give a satisfactory grade. The original designed top-course thickness of 1 in. would not suffice to overcome inequalities in the base. This course accordingly was increased to 1¾-in. in depth.

Mixing and Hauling—Laykold tempering fluid (emulsified asphalt) was delivered by truck and trailer from the plant of the American Bitumuls Co., at Inglewood, Calif., to a tank in the yard of the Sully-Miller Co. Pump and pipe connections led from the tank to the pug-mill mixer. Tempering fluid was drawn off into a special batch kettle in which the material was weighed.

For base and surface courses the project required 6,081 tons of asphaltic concrete (3,261 tons and 2,820 tons, respectively). About 33,000 gal. of asphalt emulsion were used in the two mixtures. The material was hauled about 3½ mi. from the mixing plant to the job through the heavy traffic of Long Beach.

Base Course — Trucks dumped the base mixture on marked stretches of roadway to provide 24 lb. of material per square foot, equivalent to a com-

REMODELED SPREADER AND FINISHER mounted on crawler tracks operates forward screed resting on wooden headers to distribute and strike off surface mixture across 20-ft. width for compaction to 1¾-in. thickness. Intermediate raking device and second screed of machine are not used.

MULTIPLE-BLADE DRAG of light wooden construction attached to bituminous finishing machine completes surface mixing and blading of wearing course.

pressed thickness of 2 in. Because the asphaltic mixture was no more than slightly warm when delivered, a mule-drawn fresno scraper proved an effective tool for distributing the material after it had been dumped from the truck. Most of the spreading was done with a tractor-drawn blade grader. In the hands of a good operator, the blade left a smooth surface for compaction by a 12-ton three-wheel roller. This surface was checked by straight-edging prior to rolling.

As the road could not be closed to traffic, construction was carried on a half width at a time. Traffic usually was diverted to the base as soon as the roller had fully compressed it. No apparent injuries resulted from this practice.

CLOSE BEHIND DRAG, rollers compact wearing course to 1¾-in. depth. Uniform distribution by mechanical screed and drag assure smooth rolled surface.

After the base had been sealed and covered lightly with sand it carried traffic for about 5 months with one short interruption at the time of the earthquake. The seal coat prevented raveling, and the base provided a smooth riding surface. It is possible that the roadway was improved by allowing traffic to use the base for this length of time.

Surface Course—When all danger of rains had passed, the contractor resumed operations and placed 2,820 tons of surface mixture in 11 calendar working days. A revamped Ord bituminous spreading machine mounted by the contractor on crawler tracks distributed the surface mixture across a 20-ft. width, advancing at the rate of 20 ft. per minute. This machine, which pulled a multiple-blade drag behind it, was the outstanding piece of equipment on the surfacing work. Its ability to distribute the material uniformly across the roadway eliminated need of accurate dumping by the trucks. After the hauling units had dropped their loads on the base, the mule-drawn fresno aided the spreading in front of the finishing machine.

Wooden headers laid on the base to proper grade (indicated by stretching a chalk line) supported the screed of the mechanical spreader at both ends. The screed was independent of the crawler tracks and rested directly on the headers regardless of the position of the treads. Grade of the headers was adjusted to lay 21 lb. per square foot, which produced an average compacted thickness of 1¾ in. Although the machine was equipped with two screeds and a toothed rake between them, the asphaltic concrete spread so easily that it was necessary to use only the forward screed, eliminating operation of the rake and second screed.

A light wooden drag, designed originally by Los Angeles County for laying fuel-oil mixes and known locally as a "chicken-coop drag", stirred the mixture behind the spreading machine and finally struck off the material to true grade. As shown by one of the photographs, this drag covered a large area and comprised a number of diagonal blades for moving the mixture in different directions across a 20-ft. width. Brooms attached at the rear covered tracks left by the longitudinal members of the drag.

COMPLETED 40-ft. pavement of cold-laid asphaltic concrete with total depth of 3¾ in. carries heavy traffic on smooth riding surface.

Riding Surface—Roughmeter readings of the asphaltic concrete pavement on this project show an average roughness of 14 in. per mi. for the entire length. Certain sections have an average roughness as low as 10.7 in. per mile. The cold-laid pavement compares favorably with any hot asphaltic mix laid in the southern part of the state.

Construction of the pavement was carried out under the general direction of S. V. Cortelyou, district engineer, California Division of Highways, Los Angeles. Bob Hatfield was resident engineer on the base and leveling courses, and Doc McNealy was resident engineer in charge of the surface.

TAR PAVEMENT

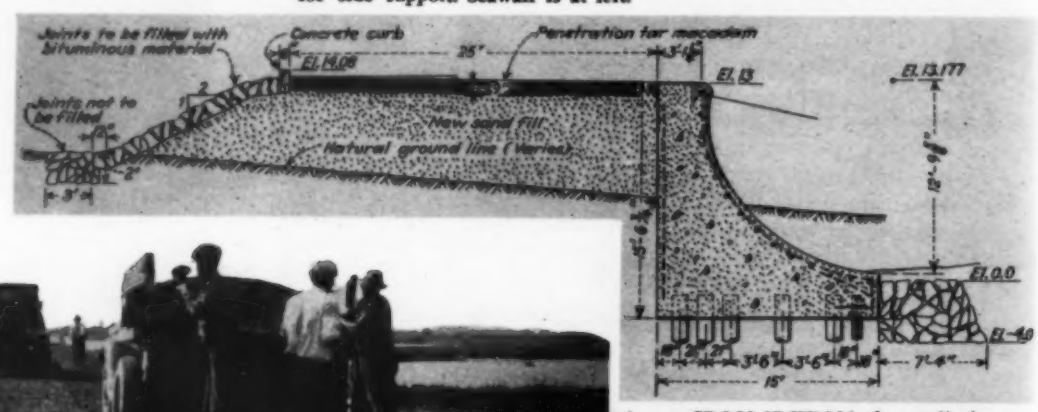
Protects Seawall and Provides Roadway

WAVES from Chesapeake Bay, breaking over the new 9,000-ft. long concrete seawall at Fort Monroe, Va., will be prevented from eroding or washing out the 60,000-cu. yd. sand fill in back of the structure by a special design tar penetration slag pavement, 9 in. thick and 25 ft. wide, built under a P.W.A. allotment to the Corps of Engineers, U.S. Army. Designed as a gravity section on wooden piles, the seawall is 15 ft. wide at the base, 15½ ft. high, with a compound curved face on the water side and a freeboard of 10 ft. above normal high tide.

The sand fill forming the subgrade for the paved roadway is retained by the back of the seawall and finished off on the land side at a 1 on 2 slope faced with a 12-in. thick revetment of stone with tar-filled joints. The bituminous surfacing, therefore, performs the dual function of providing a highway along the seawall and sealing the sand fill backing against the destructive action of water overtopping the wall during storms.

In building the pavement the sand fill forming the subgrade is first thoroughly saturated and upon it a base course of crushed slag, well graded between limiting sizes of 1 to 3½ in., is placed and compacted by rolling to a thickness of 6 in. Dry beach sand is broomed into the voids of the slag and rolling is continued until the slag refuses to take up more filler. Water is then applied, followed by additional rolling. Dry sand is again spread over the surface and flushed in to fill any remaining voids, after which rolling is resumed until the surface becomes unyielding. The compacted base then is opened to use by the contractor's trucks hauling stone for the revetment paving.

HOT TAR is applied to crushed slag top course by pressure distributor. Note concrete curb (at right) for side support. Seawall is at left.



CROSS-SECTION of seawall, showing 9-in. tar penetration pavement on sand fill backing.

CRUSHED SLAG is placed and rolled in two courses to form pavement 9 in. thick on sand fill.

At this stage of the construction an 18-in. deep concrete curb wall, 6 in. wide, is poured along the land side of the pavement to furnish side support. Revetment stone then is placed on the sloping side of the fill.

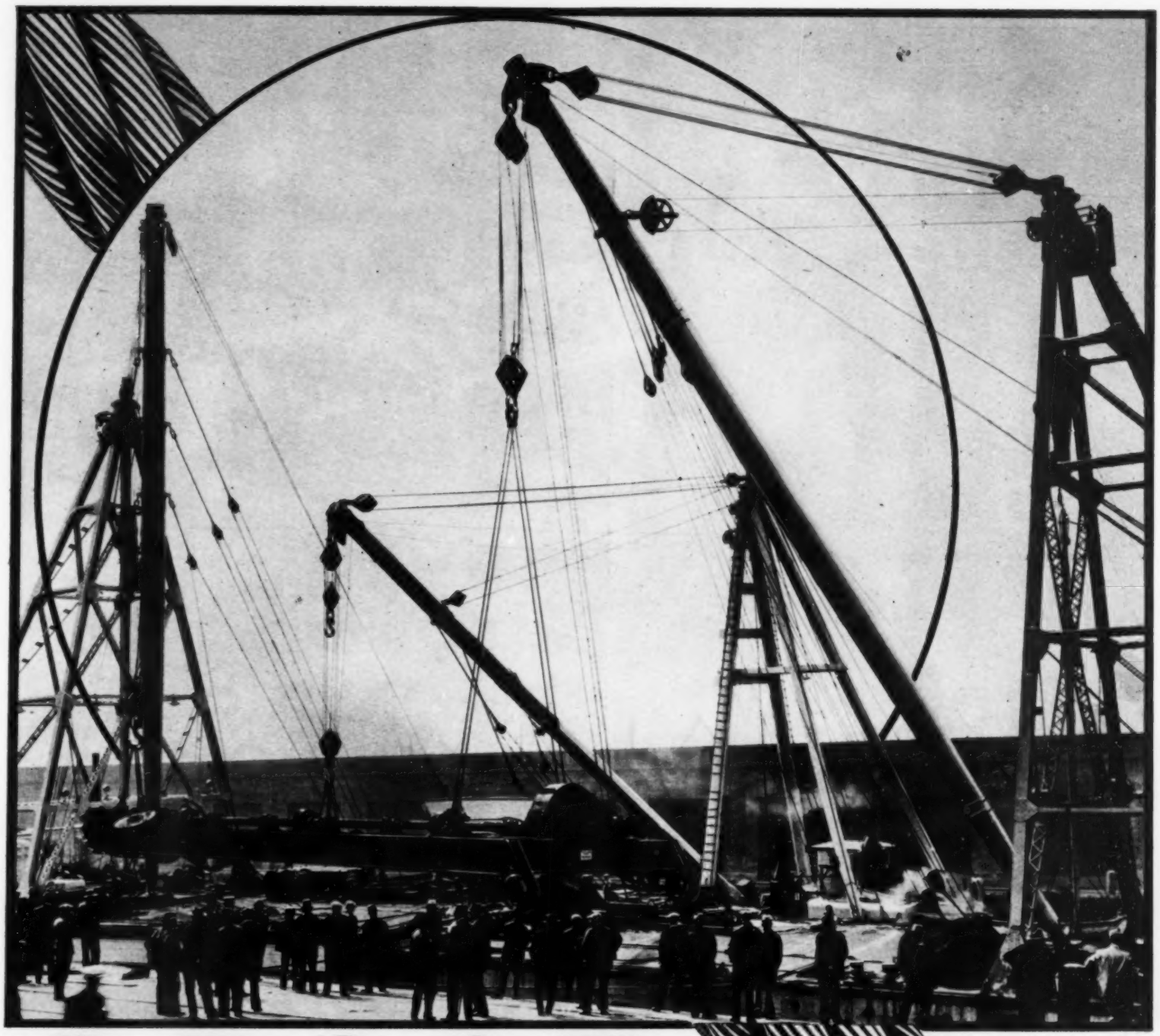
The top course of the pavement consists of additional finer slag—1¼ to 2½ in. in size—compacted by a 10-ton roller from a loose layer of 4¼-in. depth to a thickness of 3-in. The surface thus prepared is treated with hot Tarvia applied by a pressure distributor at a rate of 1.4 to 1.6 gal. per square yard. This treatment is immediately covered with ¼- to ¾-in. slag chips at a rate of 35 lb. of chips per square yard. Before the tar stiffens the chips are rolled into the voids in the larger size top course slag with a 10-ton roller, after which all loose chips are broomed off the surface. Then a seal coat of from 0.4 to 0.6 gal. of hot tar is applied and blotted with another covering of slag chips at the rate of 30 to 35 lb. per square yard. Rolling is started immediately and continued until the surface is hard and smooth.

After an interval of 10 days the paved surface is swept and a final hot tar treatment of 0.25 gal. per square yard is applied and covered with clean beach sand at the rate of 15 lb. per square yard. This sand is broomed to distribute it uniformly over the surface, but is not rolled.

In the meantime slag chips are placed in the joints between the revetment stones and the surface of the revetment is then sprayed with 1 gal. of hot tar per square yard by a hand hose extension from the pressure distributor. The tar application is covered with from 10 to 20 lb. of beach sand per square yard.

The Merritt-Chapman & McLean Corp., of Baltimore, built the seawall and tar penetration pavement, an $875,125 project, under the direction of the U.S. District Engineer Office at Norfolk, Va.

JOINTS in stone revetment on land side of fill are plugged with slag chips and sprayed with hot tar.



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(State Highways and Important County Routes)

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a. Entrance drains	Armco Corrugated Pipe
b. Cross drains	Armco Paved Invert Pipe
2 Bridges and Large Culverts	Armco MULTI PLATE (Pipe or arches)
3 Subdrains	
a. Paralleling road	Armco Perforated Pipe
b. Under pavement	Armco Perforated Pipe (with Paved Invert)

FOR SECONDARY ROADS
(County and Township Roads)

Type of Installation	Product Recommended for Best Results
1 Small and Medium Size Openings.	
a. Normal conditions	Armco Corrugated Pipe
b. For steep grades	Armco Paved Invert Pipe
c. Continuous flow	Armco Paved Invert Pipe
d. Under high fills	Armco Paved Invert Pipe
e. Diameters larger than 24 inches	Armco Paved Invert Pipe
2 Bridges and Large Drains	Armco MULTI PLATE (Pipe or arches)
3 Subdrains	Armco Perforated Pipe

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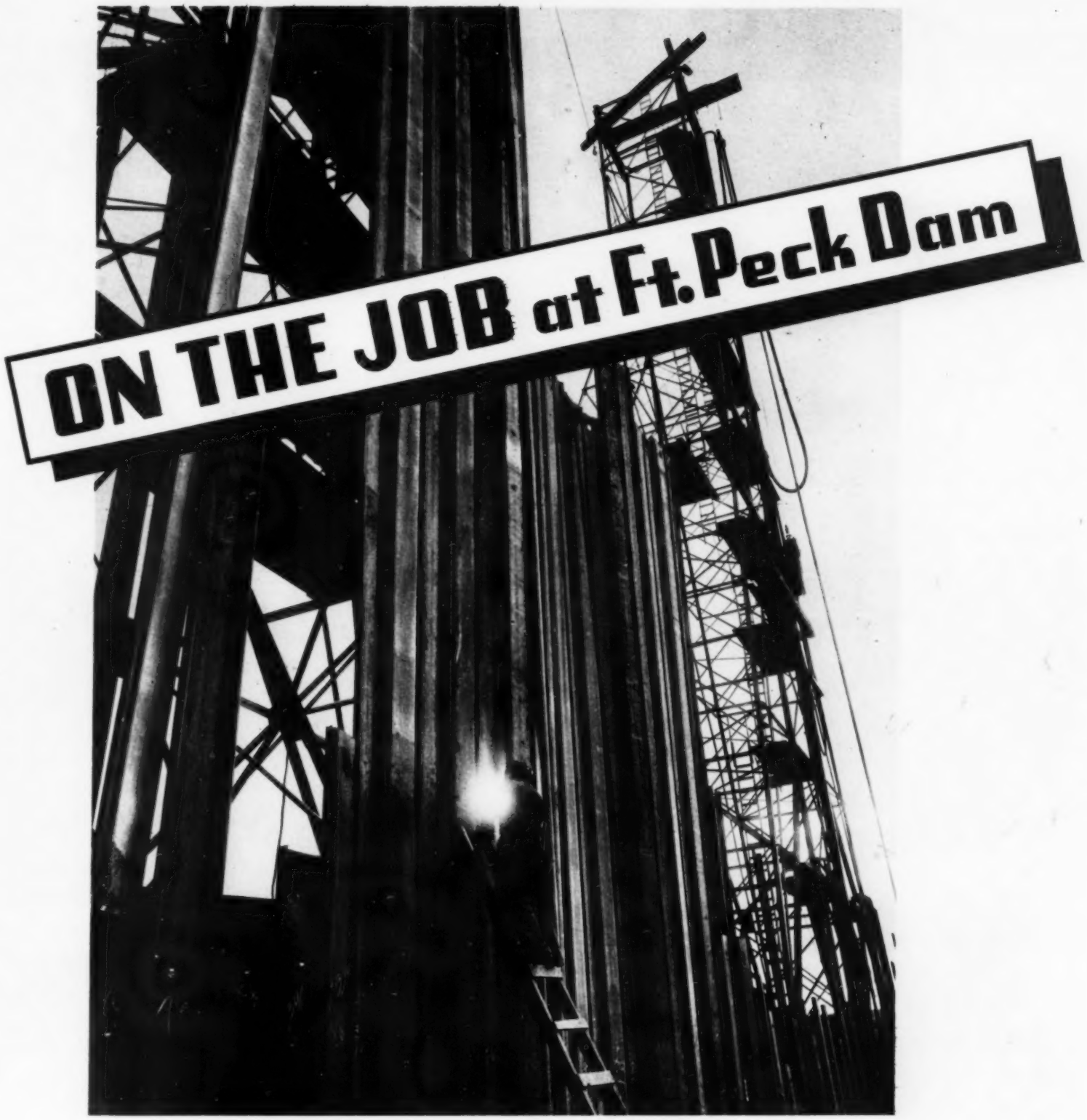

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The most impressive installation of steel sheet piling ever undertaken is that now in progress at the Fort Peck Dam. Here Illinois Steel Sheet Piling is being used in the construction of a permanent cut-off wall to prevent seepage. The piling is being driven through sand, silt, clay and gravel to the underlying shale, with penetrations up to 150 to 160 feet.

ENGINEERS: United States Engineers' Office, Kansas City, Mo., and Fort Peck, Mont.

CONTRACTORS: Frazier-Davis Construction Company and G. L. Tarlton, Contractor, St. Louis, Mo.

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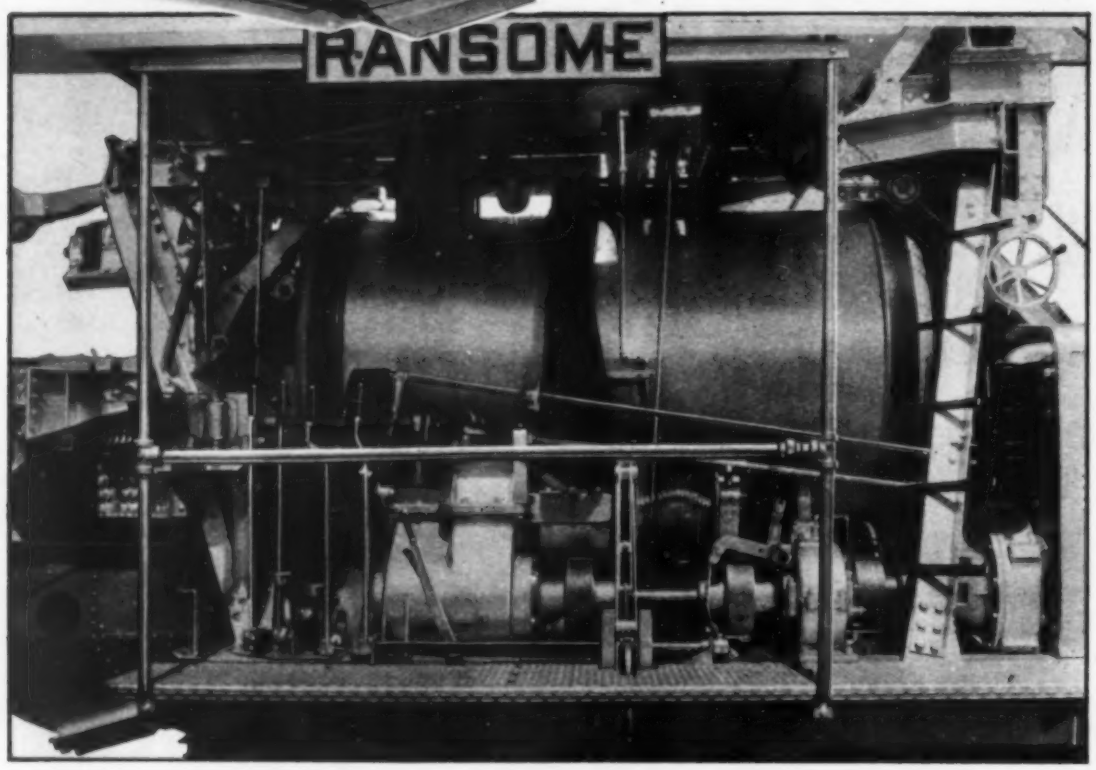

with the RANSOME DUAL-DRUM PAVER which averaged 59·56 Batches per hour

"High Production Equipment Speeds 12 Mile Paving Project"—an article in the December 1934 issue of *"Construction Methods"* tells about the performance of a Ransome Dual Drum Paver owned by the York Engineering and Construction Co., of York, Pa.

This paver operated on State Route 8, South of Butler, Pa.

From June 13 to October 12, 1934, during 937.11 hr. of actual paver operation, the Ransome Dual Drum Paver "produced 55,821 batches—an average of 59.56 batches per hour" states *"Construction Methods"*. "On August 21, the mixer produced a maximum volume of concrete for any one day. In 13.08 hr. of mixer operation, the dual drum paver produced 911 batches, *an average of 69.6 batches per hour!"*

This record substantiates the statement we made when we brought out the Ransome Dual Drum—that is approximately *50% to 75% faster than the standard 27-E!*

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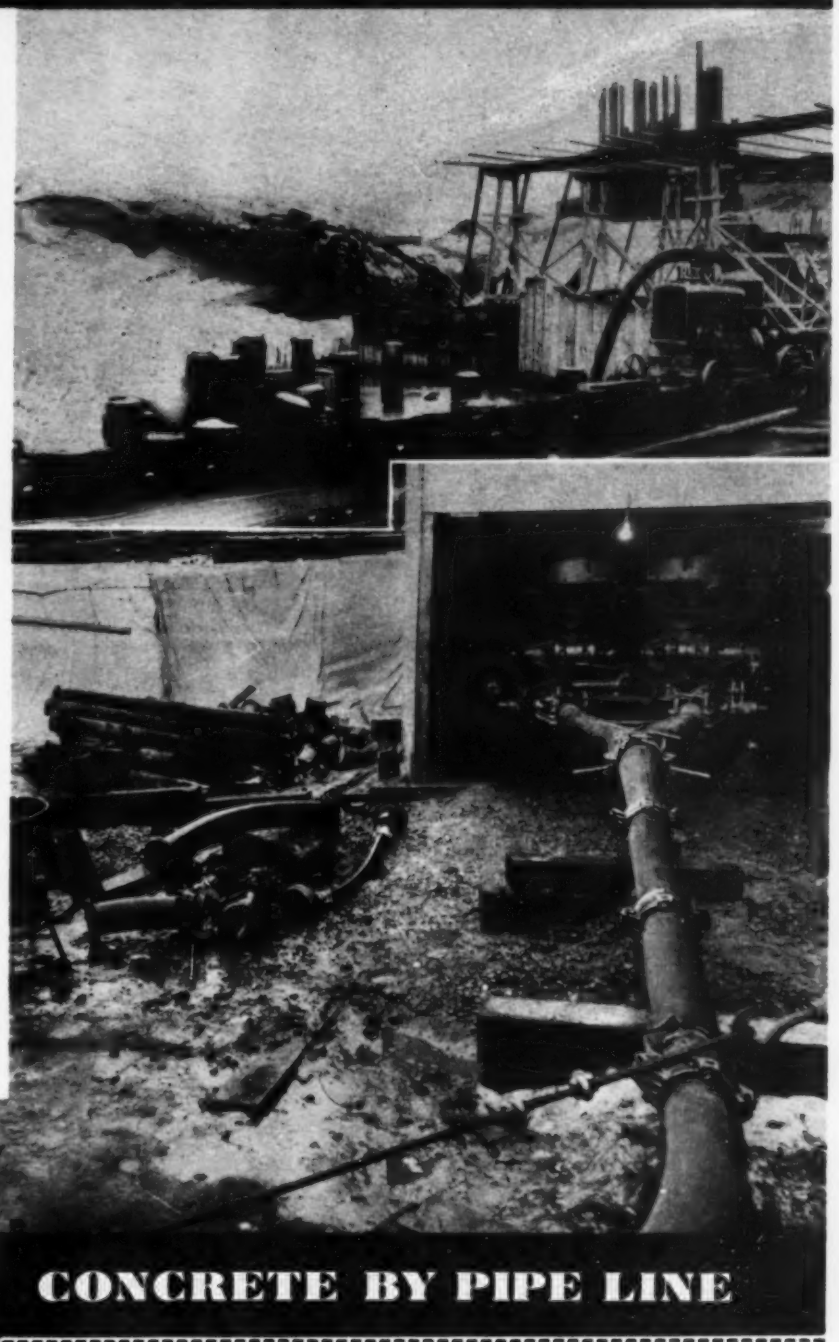

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for other information on items that interest you in the most complete line built for concrete mixing, placing and pumping.

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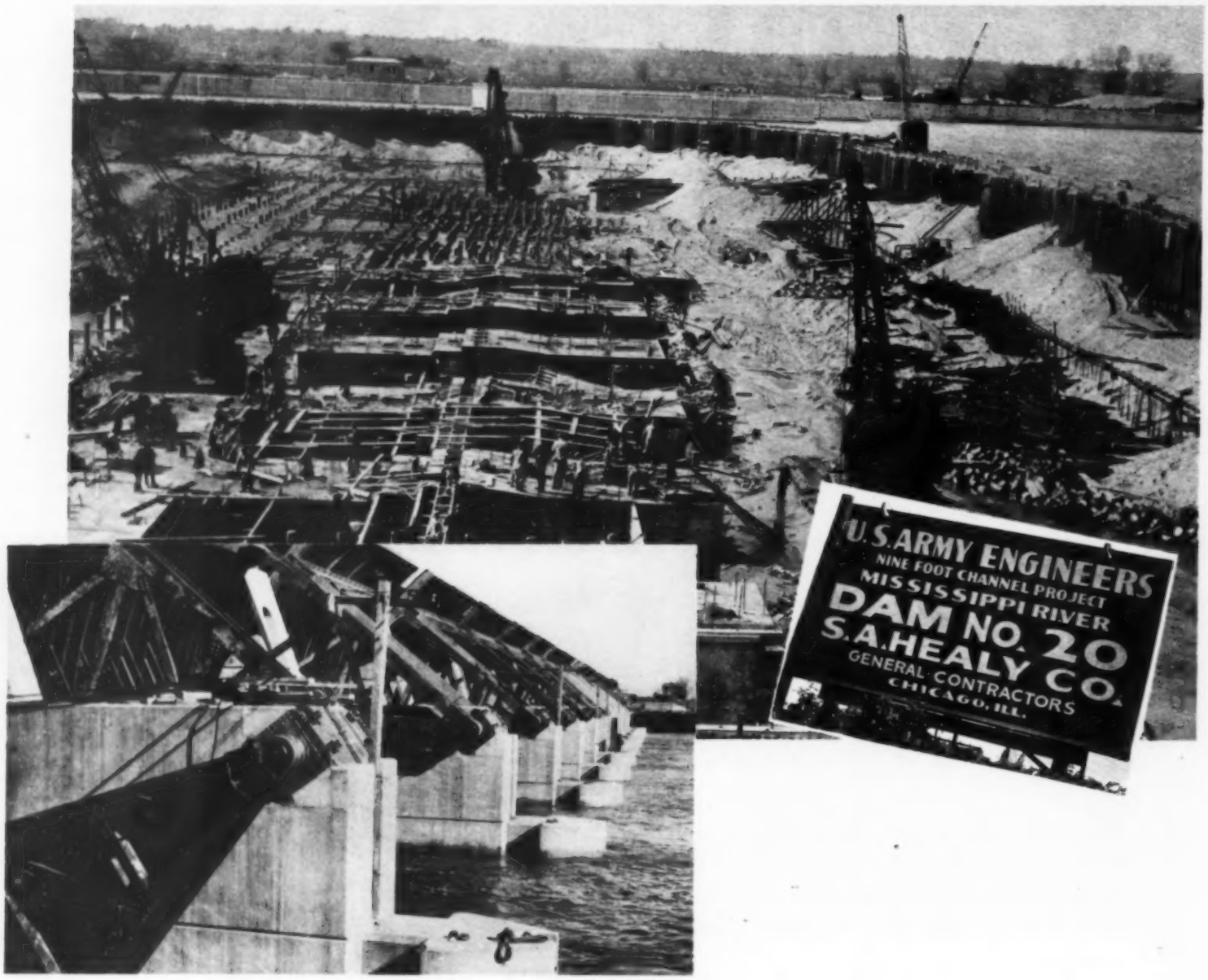

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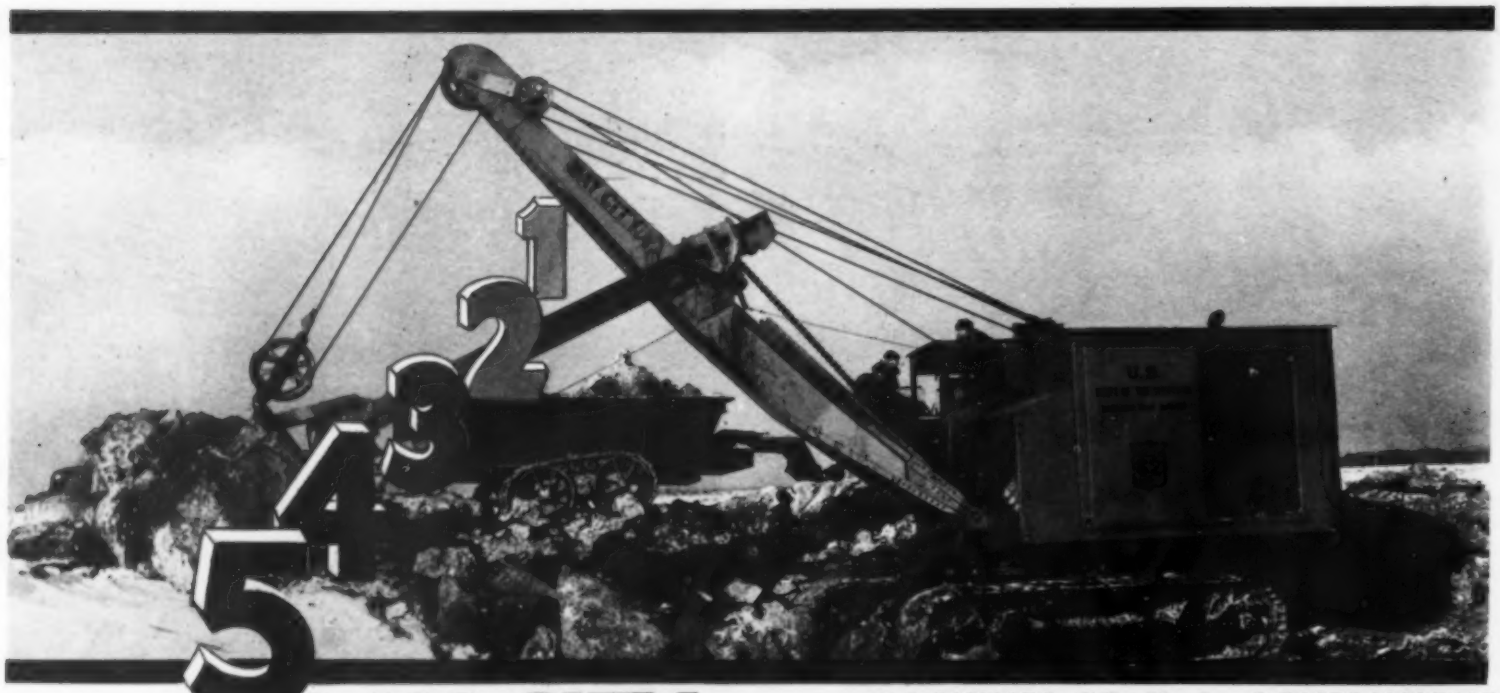

5 BAY CITY 1-2-4 MODEL 62 1-YARD MACHINES TO U. S. GOVERNMENT DURING THE PAST SIX MONTHS.

Here we show one of two 1-yd. Model 62 Bay City shovels recently purchased by the U. S. Government tearing through 18 to 20 inches of frozen soil without blasting. They are working two shifts daily, 8 hours each, for the National Park Service at Skokie Lagoons National Park, Chicago — making a record that bears out the dependability, reliability and performance that you, too, will find in any one of the nine sizes of convertible shovels, draglines, cranes and excavators, ⅜-yd. to 1¼-yd. capacity.

Since telling you of the three model 62 Diesel draglines, operating at Lake Okeechobee, word reaches us that these machines are working continuously, 24 hours a day, seven days a week. Another record that illustrates the advantages of Bay City's sturdy construction features, including powerful positive chain crowd, frictionless ball bearings throughout, drums on separate shafts and helical cut machinery gears.

If you want to move dirt economically, get a Bay City shovel.

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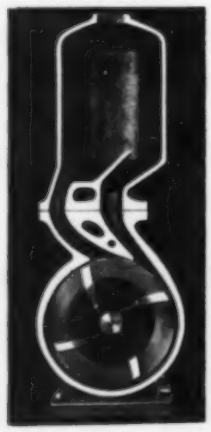
When you buy a HYDROBALANCE pump, you are buying the simplest and most effective self-priming centrifugal pump ever produced. Furthermore, you are buying rugged strength and honest capacity, because Hydrobalance pumps are LaBour pumps — and contractors everywhere know LaBour quality and integrity.

ONLY HYDROBALANCE pumps may use the patented construction shown in this illustration. The photograph shows *all the parts* essential to operation by the hydraulic balance principle. There are no valves, no floats, no springs, no adjustments. There are no tiny, one-way by-pass openings to become clogged. Yet, as has been positively demonstrated by using glass sections and indicating vanes, Hydrobalance pumps do not permit one drop of wasteful recirculation. Further proof of this positive action is seen in the fact



that LaBour Hydrobalance pumps do not lose capacity as the suction lift is increased, total head remaining unchanged.

Simplicity that means dependability — freedom from shutdowns — is inherent in Hydrobalance pumps. Rugged strength, with ample, thick-walled castings of special composition and oversize shaft and bearings, have always been a feature of LaBour pumps. LaBour Hydrobalance pumps are available in a full range of sizes and all types of drive.

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Reo Speedwagons range from ½ to 4-6 tons including Tractor-Trailers and Buses. Price from $495 up, f. o. b. Lansing, plus tax. Special equipment extra.

** Special equipment extra, prices f. o. b. Lansing, plus tax.*

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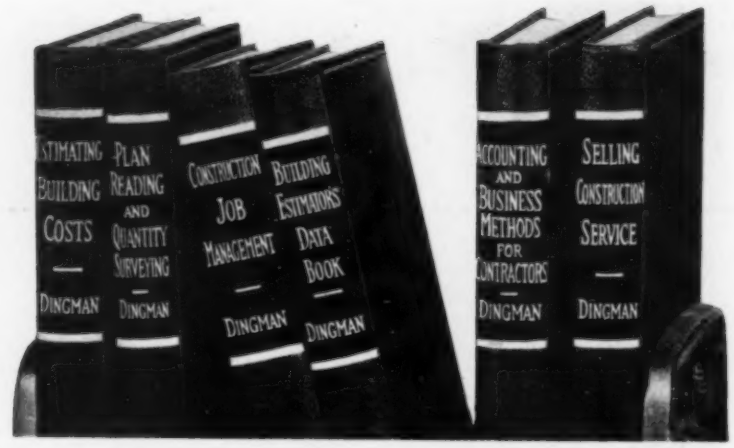

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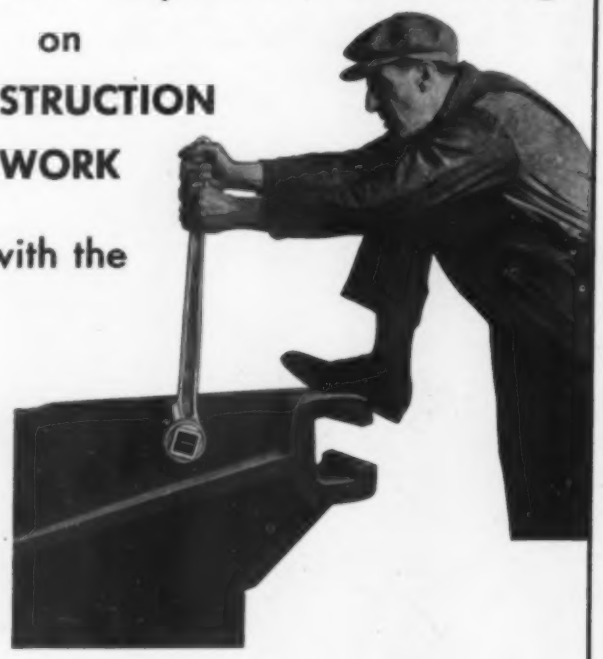

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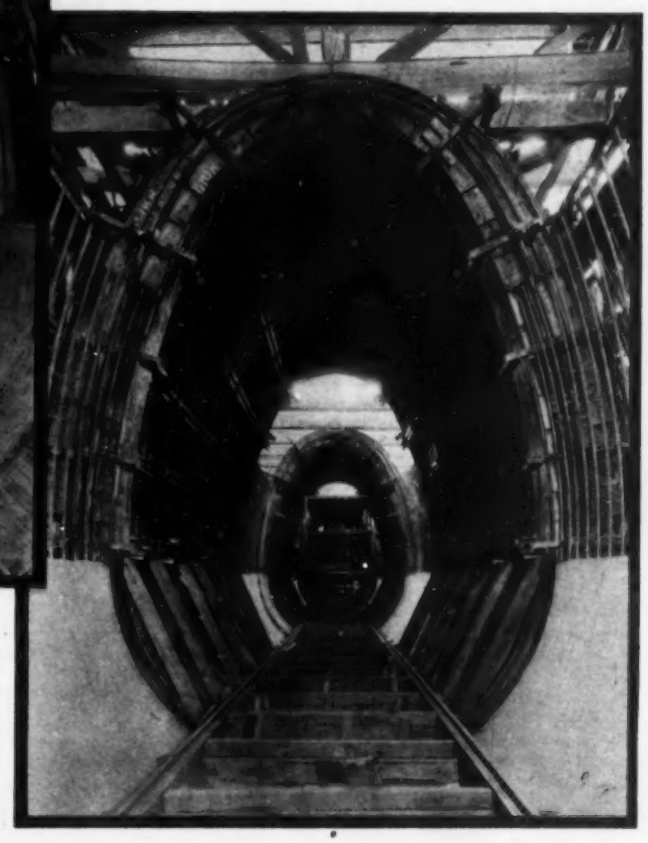

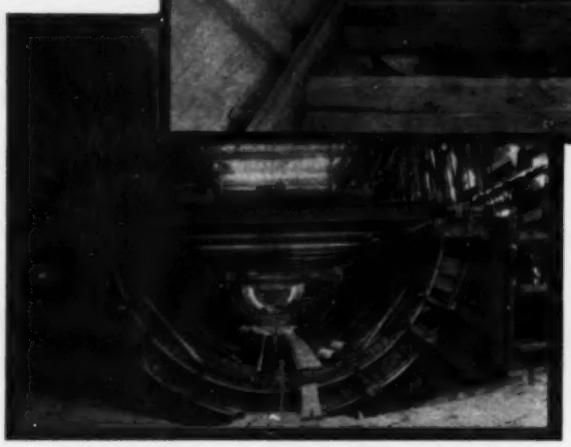

Below:—Shows Koppel arch forms with bulkhead in place.
Left:—Illustrates a completed section; note the clean finish of the concrete surface.
Lower left:—Koppel invert forms in place.

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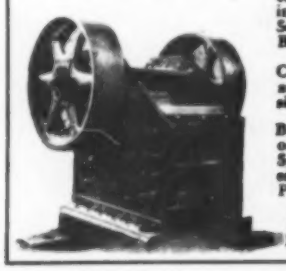
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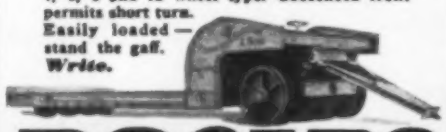
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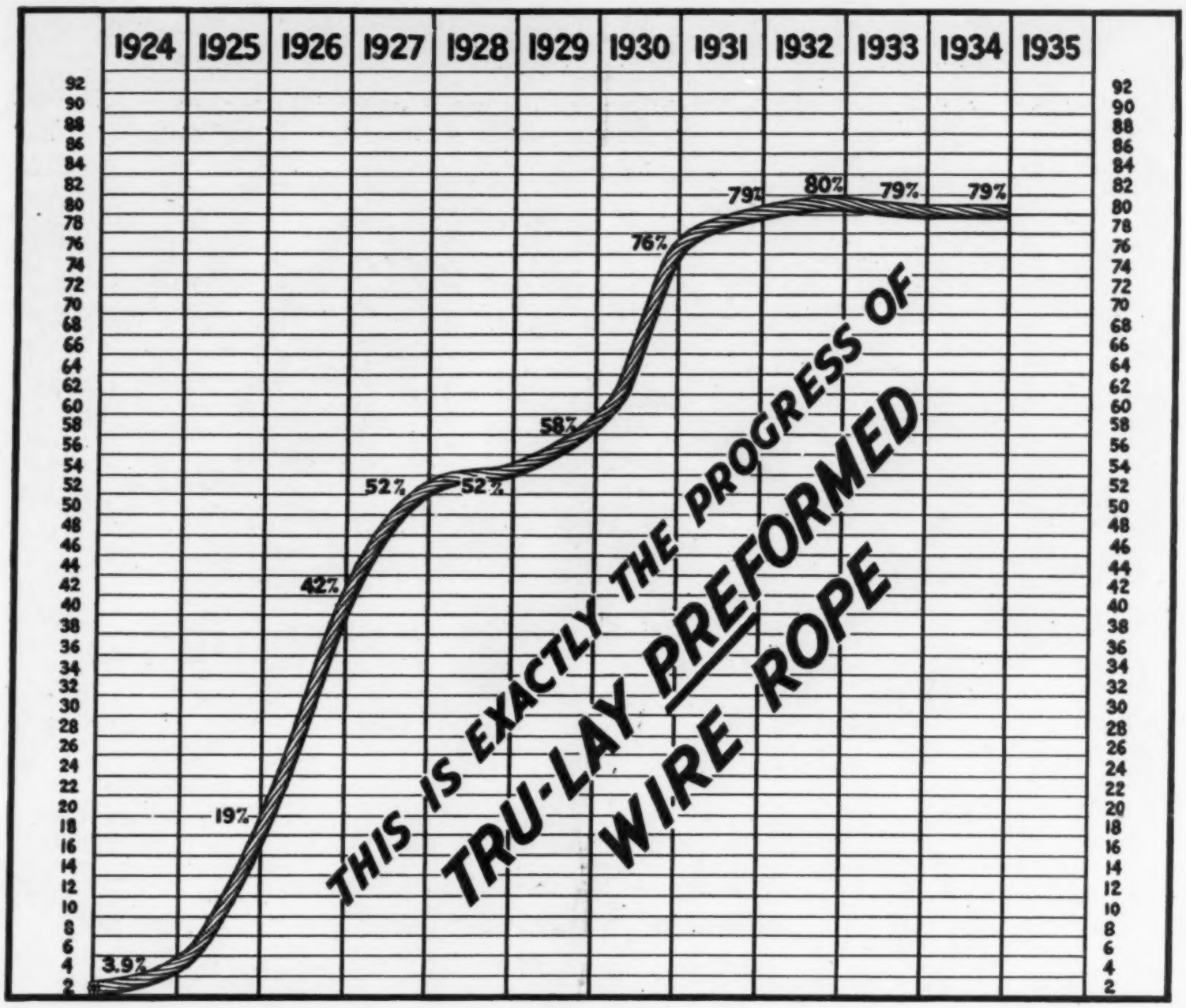

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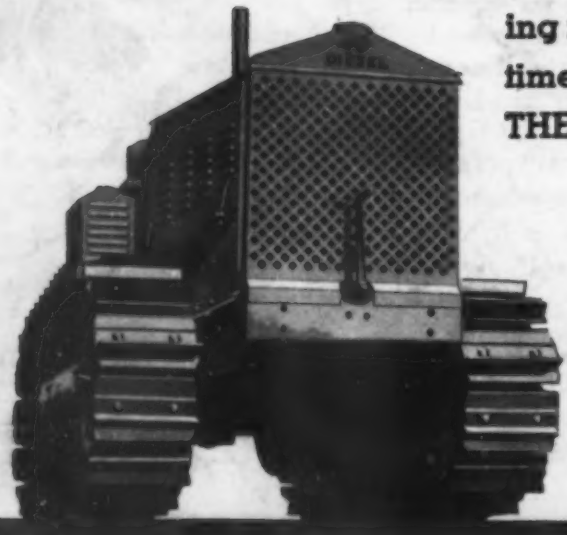

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